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March 2018 - Preliminary Engineering Report

Wastewater Treatment Facility Improvements

City of Lanesboro, Minnesota

BMI Project No. M24.115546

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Certification

Wastewater Treatment Facility Improvements
Preliminary Engineering Report

for

City of Lanesboro, Minnesota
M24.115546

March 29, 2018

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

By: ______________________
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License No. 54296

Date: 03/29/2018

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Date: 3/29/2018

Table of Contents

Figures

Tables

Pictures

Appendix

1. INTRODUCTION

A. PURPOSE

This report provides the City of Lanesboro, Minnesota with recommendations for wastewater treatment facility (WWTF) improvements to address the existing aging infrastructure and future treatment requirements. Recommendations are based on input from City staff, a visual inspection of the infrastructure, and an evaluation of facility requirements in accordance with the current recommended practices. City officials are encouraged to use the information in this report to make informed decisions on future improvements to the Lanesboro Wastewater Treatment System.

B. BACKGROUND

The Lanesboro Wastewater Treatment Facility was originally constructed in 1938 as a single-stage trickling filter process and is designated as a Class C treatment facility. The facility has received minor upgrades over the years to maintain the aging treatment processes. The facility continuously discharges treated effluent to the South Branch of Root River (SD001) in accordance with National Pollutant Discharge Elimination System (NPDES) Permit No. MN0020044. Root River is designated as a Class 1B, 2A, 3B, 4A, 4B, 5, 6 surface water suitable for domestic consumption, aquatic life, and recreation. A copy of the current NPDES discharge permit is included in Appendix A.

Over the past 80 years, the existing facility has provided adequate treatment to meet historical NPDES discharge requirements; however, much of the existing equipment and infrastructure is well past its expected useful life and in need of significant improvements in the near future. There is also a potential for more stringent treatment requirements for nutrients (e.g. phosphorus and nitrogen) over the next few permit cycles, which the existing facility is not equipped to meet. In order to be proactive, the City of Lanesboro has retained Bolton & Menk, Inc. to develop this Preliminary Engineering Report to explore alternatives that improve the existing system and provide the City a long-term solution for wastewater treatment.

C. REPORT ORGANIZATION

To adequately address the major issues, this report is organized into eight (8) sections. Section 2 discusses project planning and population trends; Section 3 provides a review of the current and future design conditions; Section 4 provides an evaluation of the existing wastewater treatment infrastructure; Section 5 summarizes the project needs; Section 6 provides an evaluation of alternatives and associated cost analysis; Section 7 provides recommendations and implementation of the proposed wastewater system improvements; and Section 8 summarizes conclusions and recommendations.

D. LIST OF ABBREVIATIONS

Table 1.1 – List of Abbreviations	
ADW	Average dry weather
AWW	Average wet weather
BNR	Biological nutrient removal
CBOD	Carbonaceous biochemical oxygen demand
EPA	Environmental Protection Agency
HMI	Human-machine interface
HVAC	Heating, ventilation, and air conditioning
lbs./day	Pounds per day
MCC	Motor control center
MGD	Million gallons per day
mg/L	Milligrams per liter
MHI	Median household income
MPCA	Minnesota Pollution Control Agency
NEC	National Electric Code
NH_3-N	Ammonia-Nitrogen
NPDES	National Pollutant Discharge Elimination System
O&G	Oil and grease
OSHA	Occupational Safety and Health Administration
PHWW	Peak hourly wet weather
RD	Rural Development
RTU	Remote telemetry unit
SCADA	Supervisory control and data acquisition
SIU	Significant Industrial User
TKN	Total Kjeldahl Nitrogen
TMDL	Total maximum daily loading
TN	Total Nitrogen
TSS	Total suspended solids
TP	Total Phosphorus
USDA	United States Department of Agriculture
VFD	Variable frequency drive
WLA	Waste load allocation
WWTF	Wastewater treatment facility

2. PROJECT PLANNING

A. PROJECT PLANNING AREA

The improvements project discussed in this report is for the City of Lanesboro in Fillmore County, Minnesota. The area served by the proposed improvements are within the city limits of Lanesboro. Figure 2.1 shows the project planning area encompassed by this report and the improvements discussed herein.

The location of the existing wastewater treatment facility is outside of the Federal Emergency Management Agency (FEMA) designated 100-year floodplain and will be protected during a 100-year flood event and operational during a 25-year flood event. Proposed locations of improvement alternatives are within the designated 100-year floodplain and would include provisions to ensure the facility is protected during a 100-year flood event and operational during a 25-year flood event. No other historical sites or sensitive habitats are known to exist in the proposed project areas.

B. PROJECT PLANNING PERIOD

Wastewater treatment facilities are typically designed based on a 20-year planning period, as it is generally not feasible to make frequent changes in the capacity of a wastewater treatment facility. A design year of 2040 is used for this evaluation. Projected wastewater flows and loadings are determined using a combination of population trends and historical per capita flow and loading values.

C. ENVIRONMENTAL RESOURCES

Environmental resources surrounding the planning area include the South Branch of Root River and lightly wooded areas along the river and adjacent state trail to the north. General land use surrounding the planning area include industrial and residential zoning, as well as state-owned land. Rural agricultural land and wooded areas are present outside of the City limits.

D. POPULATION PROJECTIONS

There are a number of methods available for predicting population trends for cities such as Lanesboro. Historical city and county population trends are reviewed. Future trends can be predicted using a variety of mathematical projections including arithmetic, geometric, and linear regression methods. Additionally, the Minnesota State Demographic Center (SDC) publishes projections for all counties in Minnesota. The most recent projection by the SDC was complete in March 2017.

Table 2.1 and Figure 2.2 show historical and projected populations for the City of Lanesboro and Fillmore County. The SDC projects the population of Fillmore County to decrease slightly over the design period. Historically, the City of Lanesboro's population has decreased by 4.2% between the years of 2000 to 2015, equating to a roughly 0.3% annual decline in population. Meanwhile, the county population decreased by 1.4%, or a 0.09% annual decline. Despite these trends, City officials believe the population will stabilize over the duration of the design period. Therefore, the selected 2040 design population used for the analysis is equivalent to the 2015 American Community Survey (ACS) population estimate of 755.

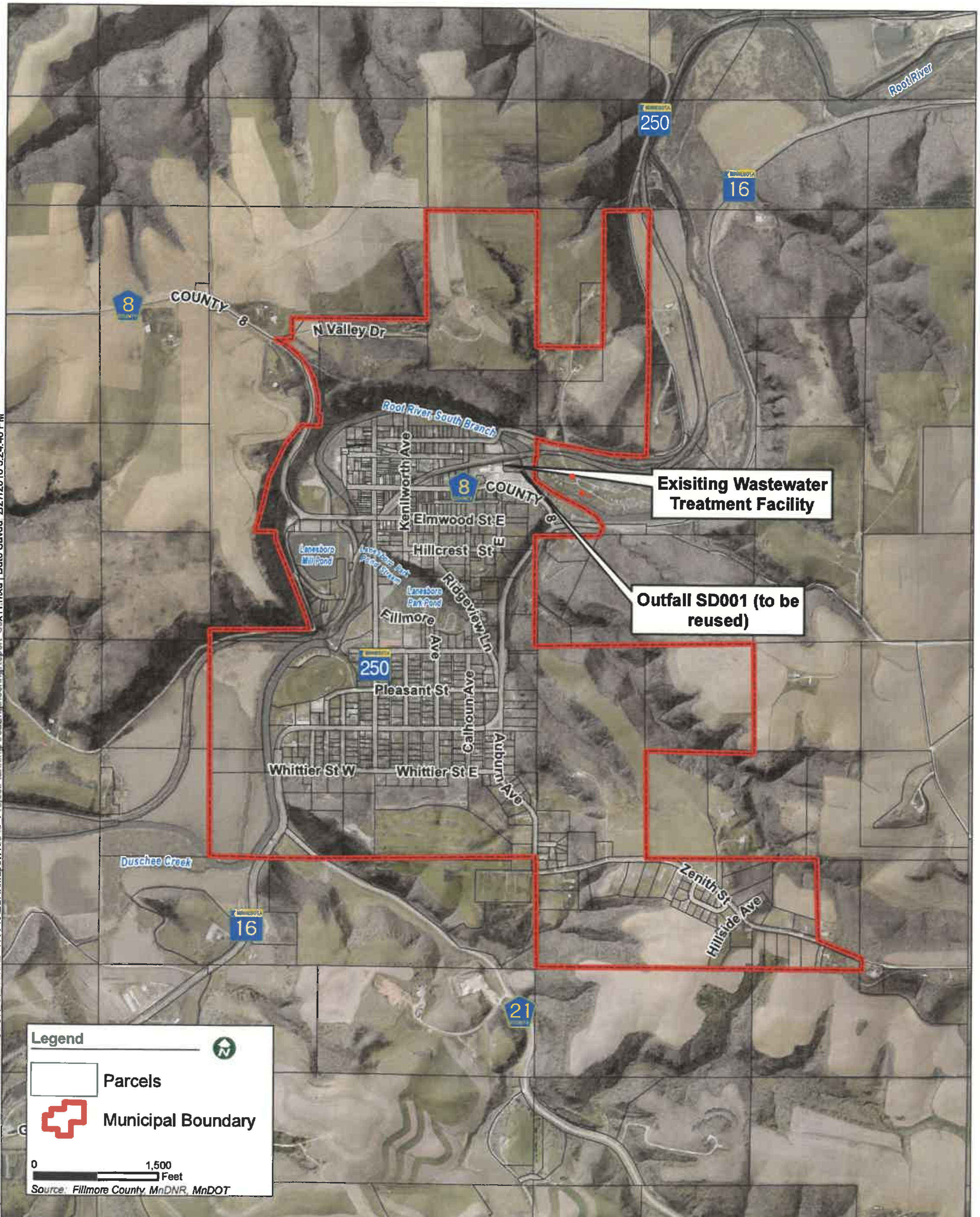

Root River
250
16
8
COUNTY 8
N Valley Dr
Root River South Branch
Kenilworth Ave
8
COUNTY 8
Exisiting Wastewater Treatment Facility
Elmwood St E
Hillcrest St E
Lanesboro Mill Pond
Lanesboro Park Pond Stream
Lanesboro Park Pond
Ridgeview Ln
Fillmore Ave
Outfall SD001 (to be reused)
250
Pleasant St
Calhoun Ave
Auburn Ave
Whittier St W
Whittier St E
Duschee Creek
Zenith St
Hillside Ave
16
21
Legend
Parcels
Municipal Boundary
0
1,500
Feet
Source: Fillmore County, MnDNR, MnDOT

Table 2.1 – Population Projections			
Year	Fillmore County [(1)]	City of Lanesboro	
		Historical Trends[(2)]	Design Population
1990	20,777	858	858
1995	20,909	827	827
2000	21,122	788	788
2005	21,081	757	757
2010	20,866	754	754
2015	20,832	755[(3)]	755
2020	*20,639*	*738*	*755*
2025	*20,437*	*728*	*755*
2030	*20,222*	*718*	*755*
2035	*20,001*	*707*	*755*
2040	*19,778*	*697*	*755*

(1) County projections calculated by both SDC projections and linear regression modeling of historical data

(2) 2020 to 2040 projections calculated by linear regression modeling of historical data

(3) 2015 population estimate per American Community Survey (ACS)

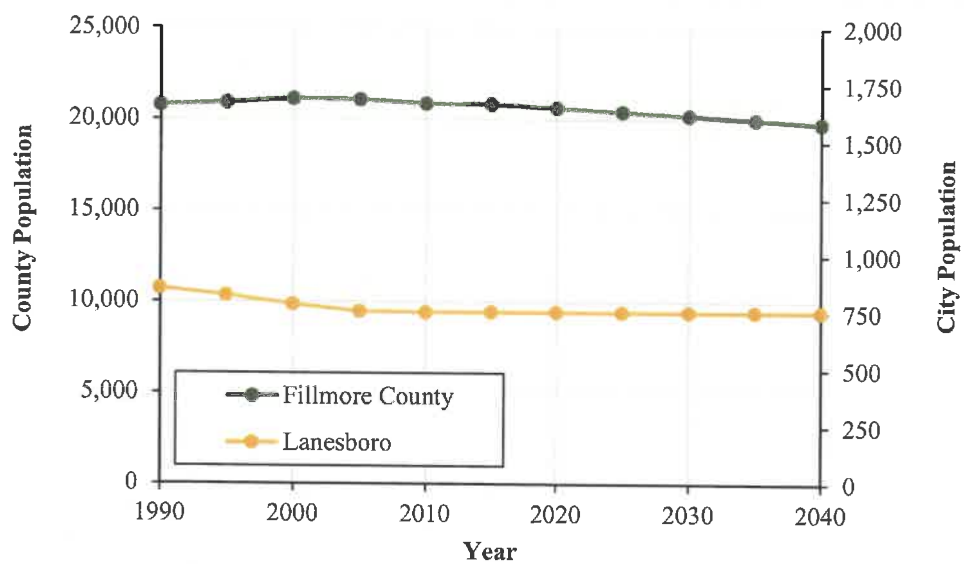


Figure 2.2 – City and County Population Projections

3. DESIGN CONDITIONS

A. GENERAL

Prior to formulating alternatives for wastewater system improvements, design conditions must be first be determined. Design conditions help characterize the strength and volume of wastewater to be treated over the duration of the project planning period. These parameters then dictate the type of infrastructure improvements necessary to meet the facility's NPDES discharge permit requirements. This section provides a detailed analysis of historical and future design conditions for the City of Lanesboro's wastewater treatment system.

B. HISTORICAL FLOWS AND LOADINGS

1. Flow Monitoring Data

a) Total Plant Influent Flow Monitoring

The City of Lanesboro records daily influent flows in monthly Discharge Monitoring Reports (DMRs) as required by the facility's NPDES permit (see Appendix A for a copy of the current permit). The recorded flows are used to evaluate current flow trends and develop future flow projections. The flows to the treatment facility are measured by runtime meters on the influent pumps using a known pumping rate. A summary of monthly average and maximum daily flows for the past six years is presented in Table 3.1. Figure 3.1 illustrates average daily and maximum flow trends over the same time frame, respectively. Figure 3.3 shows monthly precipitation.

Over the past six years, average annual flow has ranged from 0.073 to 0.088 MGD, with a trend that is positively correlated with annual precipitation. Seasonal spikes in flow are apparent between the months of October through April. Late fall and winter months are typically characterized by low flows in most communities. As discussed in subsequent paragraphs, this abnormality may be explained by internal recycle flows at the treatment plant. Seasonal spikes in March and April are expected due to snow melts and early season rain events. Monthly spikes in peak flow shown in Figure 3.1B are directly linked with monthly spikes in precipitation shown in Figure 3.2. This indicates infiltration and inflow may be an issue in the collection system.

b) Recycle Flows

During winter months and low flow periods, the operators recirculate effluent water to provide continuous flow to the trickling filter. This recycled flow is measured as additional influent, which makes the recorded flows higher than actual flow. Without detailed records of daily recycled flows, it is difficult to accurately determine the impact it has on measured influent flows. However, these recycled flows only impact the average flows recorded at the facility. They do not significantly impact peak flows, which are more important for design and sizing considerations of improvements.

c) Seasonal Transient Flows

Transient flows are from short-term sources such as local festivals and tourist events that may result in temporary spikes in wastewater volume. Historical monitoring data includes monthly and daily values that reflect seasonal transient flows. Therefore, these flows are not evaluated separately and are considered part of the normal seasonal variation in wastewater volume.

Table 3.1 – Historical Wastewater Flow – Lanesboro, MN

	2012		2013		2014		2015		2016		2017[1]		6-year	
Month	Monthly Average (MGD)	Daily Max (MGD)	Monthly Average (MGD)	Daily Max (MGD)	Monthly Average (MGD)	Daily Max (MGD)	Monthly Average (MGD)	Daily Max (MGD)	Monthly Average (MGD)	Daily Max (MGD)	Monthly Average (MGD)	Daily Max (MGD)	6-Year Monthly Average (MGD)	6-Year Daily Max (MGD)
January	0.087	0.114	0.070	0.079	0.081	0.094	0.080	0.090	0.079	0.104	0.085	0.144	0.080	0.144
February	0.079	0.102	0.074	0.096	0.109	0.147	0.070	0.080	0.080	0.104	0.093	0.121	0.084	0.147
March	0.071	0.082	0.076	0.139	**0.115**[2]	0.134	0.070	0.090	0.081	0.110	0.089	0.109	0.084	0.139
April	0.078	0.129	0.086	0.140	0.100	0.131	0.080	0.120	0.078	0.105	0.084	0.097	0.084	0.140
May	0.063	0.099	0.090	0.127	0.071	0.090	0.080	0.100	0.074	0.100	0.078	0.100	0.076	0.127
June	0.071	0.098	0.097	0.242	0.095	0.214	0.070	0.090	0.071	0.105	0.075	0.116	0.080	0.242
July	0.090	0.113	0.077	0.105	0.069	0.082	0.070	0.090	0.072	0.110	0.069	0.080	0.075	0.113
August	0.080	0.131	0.079	0.106	0.070	0.100	0.070	0.100	0.073	0.103	0.068	0.105	0.073	0.131
September	0.084	0.103	0.076	0.116	0.080	0.110	0.068	0.102	0.086	**0.243**[3]	0.063	0.075	0.076	0.243
October	0.084	0.108	0.100	0.175	0.090	0.130	0.061	0.073	0.074	0.110	--	--	0.082	0.175
November	0.079	0.092	0.082	0.101	0.090	0.110	0.076	0.135	0.078	0.095	--	--	0.081	0.135
December	0.073	0.090	0.089	0.103	0.080	0.090	0.076	0.116	0.078	0.091	--	--	0.079	0.116
Yearly Average/Max	0.078	0.131	0.083	0.242	0.088	0.214	0.073	0.135	0.077	0.243	0.078	0.144	0.080	0.243

(1) Data from October to December 2017 unavailable on MPCA DMR data browser at time of report

(2) Maximum monthly average flow over six-year period, exceeds current design AWW of 0.110 MGD

(3) Daily maximum flow over six-year period is lower that current design PHWW flow of 0.245 MGD

d) MPCA Infiltration and Inflow Analysis

The MPCA has developed guidelines to provide a comprehensive and systematic approach to analyze I&I. These guidelines were used to determine if I&I is considered excessive in the City of Lanesboro's wastewater collection system. The following are definitions of inflow and infiltration as provided by the MPCA guidelines:

- *Infiltration* – is water other than wastewater that enters a sewer system (including service sewer connections and foundation drains) from the ground through broken or defective pipes, pipe joints, connections, manholes, and wet basements.
- *Inflow* – is water other than wastewater that enters a sewer system (including sewer service connections) through sources such as, but not limited to, roof leaders, foundation drains, yard drains, area drains, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, storm waters, surface runoff, street wash water, or other drainage structures.
- *Excessive infiltration* – Infiltration is excessive if the quantity of flow (domestic base flow and infiltration) is greater than 120 gallons per capita per day (gpcd). The quantity of flow was determined using the maximum 90-day rolling average flow over the past six years.

  108,000 gpd / 755 people = 143 gpcd (excessive)

- *Excessive Inflow* – Inflow is excessive if the quantity of flow during storm events that results in chronic operational problems related to the hydraulic overloading of the treatment system or that results in a total flow of more than 275 gpcd (domestic base flow plus infiltration and inflow). The flow during storm events was determined using the maximum daily flow over the past six years.

  243,000 gpd / 755 people = 322 gpcd (excessive)

According to MPCA criteria, the City of Lanesboro exceeds the threshold values of excessive infiltration and inflow by nearly 20 percent for each category, which validates the concerns expressed by City staff. This has potential implications on wastewater treatment, especially concerning excessive inflow during storm events that may hydraulically overload the system and impact treatment performance.

In order to reduce infiltration and inflow, the first step is to identify the source(s) of the issue. There are a number of methods available, including the following:

- *Residential/Commercial sump pump and foundation drain inspections* – involves taking an inventory of all residential sump pump and drain tile installations to verify none discharge directly or indirectly to the sanitary sewer system. The City has a sump pump ordinance in place that allows inspections of new and existing building sewers.
- *Smoke testing* – identifies sources of inflow and infiltration by setting up a blower and pumping a non-toxic, pressurized smoke through sewer mains and residential lines. The smoke helps identify any leaks or cross-connections in the sanitary sewer system.

- *Dye testing* – identifies sources of inflow by adding a NSF approved tracing dye to potential cross-connections (storm sewer, foundation drains, etc.) to verify whether or not any specific drains flow to the sanitary sewer system.
- *Sewer televising* – identifies sources of inflow and infiltration by taking camera footage of the interior sanitary sewer piping. The camera footage helps identify broken or defective piping, offset joints, and potential cross-connections.
- *Manhole inspections* – involves taking an inventory of all sanitary manholes throughout the collection system to identify leaking joints, covers, and other installation or age-related issues.

While I&I is excessive, it will likely not lead to increased cost of treatment as the facility is primarily designed around average flows and loadings. The City cannot reasonably expect to lower I&I enough to make a significant impact on WWTF design.

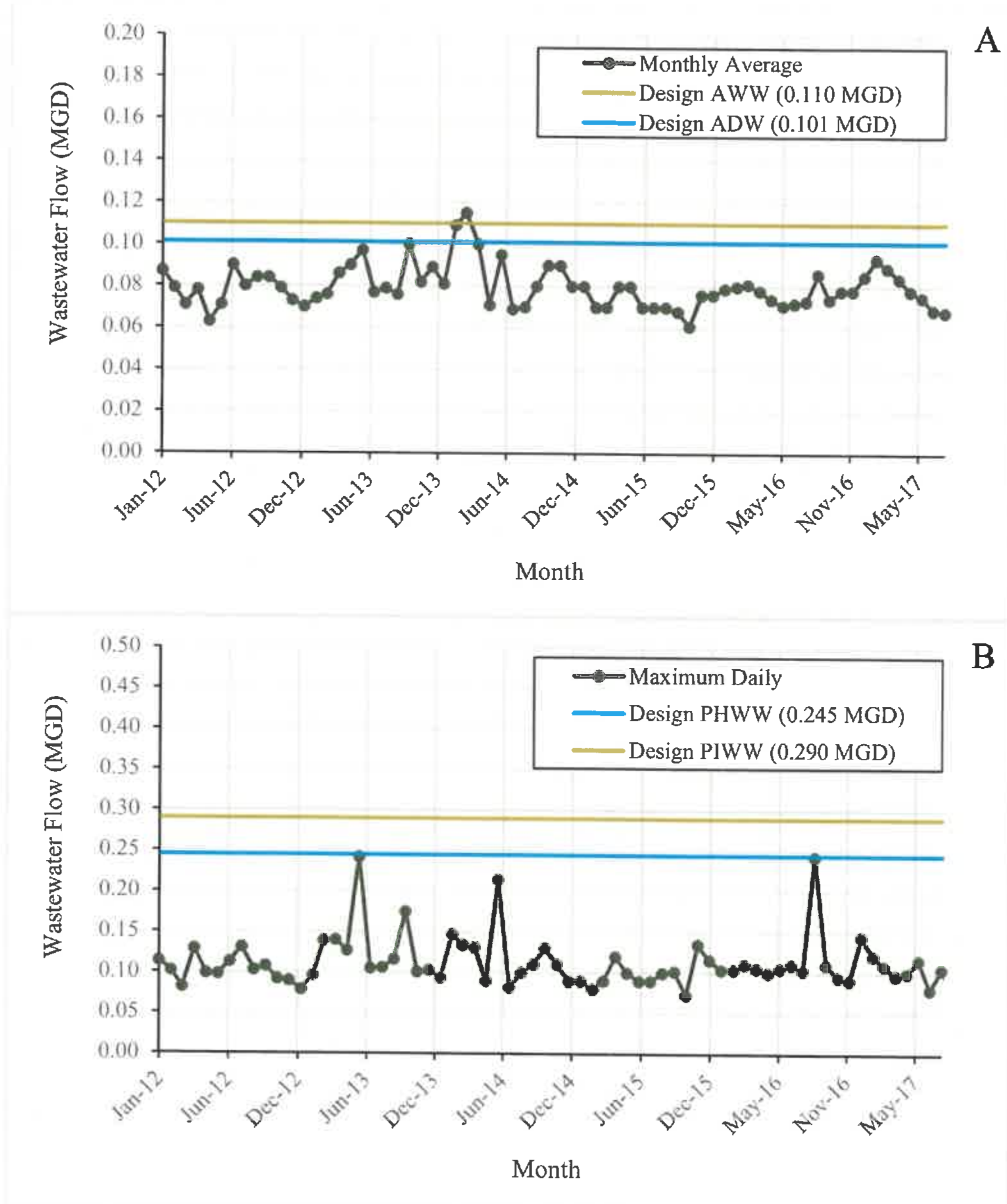


Figure 3.1 – Historical Monthly Average (A) and Maximum Daily (B) Wastewater Flows

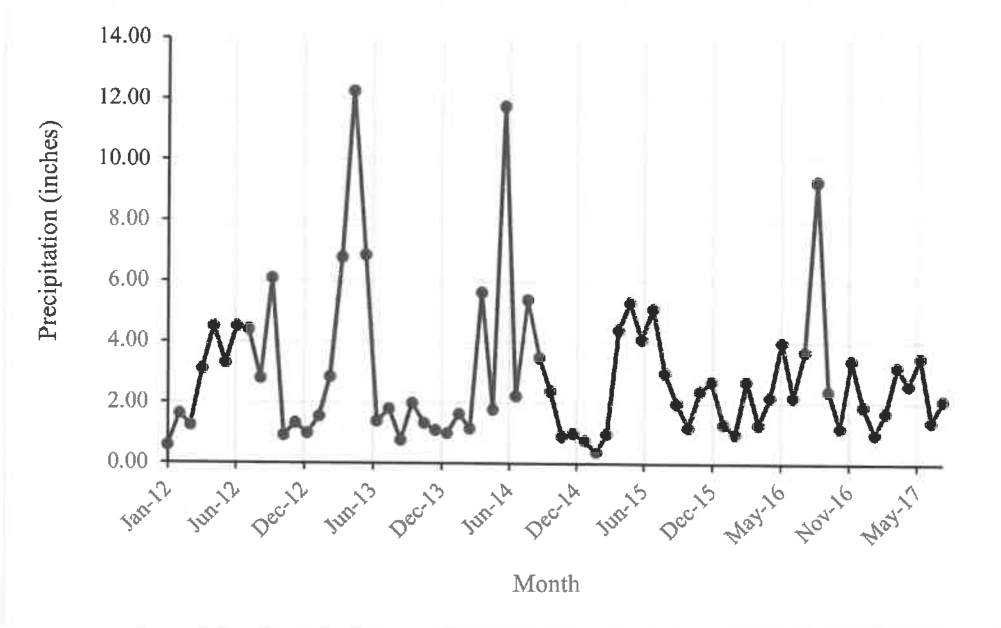


Figure 3.2 – Historical Monthly Precipitation

e) Industrial Flows

The City of Lanesboro does not have any significant industrial users (SIUs) that discharge to the treatment system. Based on discussions with City staff, there are no plans to provide sanitary service to any existing or new industrial users over the 20-year design period. Thus, provisions for future industrial growth are not considered in the design flow criteria.

The existing wastewater facility included capacity for a small cheese plant that discontinued operation years ago.

2. Load Monitoring Data

a) Total Plant Influent Loads Monitoring

The City of Lanesboro monitors influent wastewater pollutant loadings at sample station WS001 as required by the facility's NPDES discharge permit. The pollutant parameters include 5-day carbonaceous biochemical oxygen demand ($CBOD_5$), total suspended solids (TSS), total phosphorus (TP), and pH. A summary of historical monitoring data (January 2012 to present) is presented in Table 3.2. Figures 3.3, 3.4, and 3.5 illustrate monthly fluctuations for $CBOD_5$, TSS, and total phosphorus, respectively.

The following is a short discussion on each pollutant parameter concerning historical monitoring and trends:

- *$CBOD_5$* – since January 2012, the average $CBOD_5$ concentration has been 236 mg/L. This is slightly below the current design average concentration of 268 mg/L as outlined in the City's NPDES permit, although this value has been exceeded on numerous individual months. The historical average $CBOD_5$ mass loading is 156 lbs/day, with a maximum monthly average of 274 lbs/day. The current design loading is 246 lbs/day. On a year-to-year basis, influent $CBOD_5$ concentration and loadings have seen an upward trend.

- *TSS*: influent TSS concentration has averaged 265 mg/L, with average mass loading of 173 lbs/day. The maximum monthly average TSS mass loading is 774 lbs/day, which appears to be a significant outlier relative to historical trends. On a year-to-year basis, TSS loadings have been fairly consistent since 2013. The existing facility does not have any design criteria for suspended solids.
- *Total Phosphorus*: influent total phosphorus has averaged 6.72 mg/L, which an average mass loading of 4.4 lbs/day. The maximum monthly average phosphorus loading is 8.1 lbs/day. On a year-to-year basis, phosphorus concentration and loadings have been fairly consistent, with monthly spikes occurring in 2015. The existing facility does not have any design criteria for total phosphorus.
- *Pollutant Loading Rates*: Common per capita design loading rates, given by the *Recommended Standards for Wastewater Facilities – 2014 Edition* (commonly known as the Ten State Standards), are 0.17-0.22 lbs. $CBOD_5$/capita/day and 0.20-0.25 lbs. TSS/capita/day. A common loading for total phosphorus, according to Metcalf & Eddy (2003), is 0.008 lbs. TP/capita/day.

Table 3.2 shows average loading rates for Lanesboro's wastewater, which combines all residential and commercial sources. On average, the $CBOD_5$ and TSS loading rates are within the typical design ranges specified above. Total phosphorus has been below the typical range, averaging 0.006 lbs. TP/capita/day.

Table 3.2 – Historical Wastewater Loading – Lanesboro, MN

Parameter	Unit	2012	2013	2014	2015	2016	2017	6-Year Average
Average Flow	MGD	0.078	0.083	0.088	0.073	0.077	0.078	0.079
$CBOD_5$	mg/L	159	192	235	306	262	270	236
	lbs/day	104	133	171	185	168	176	156
	lbs/capita/day(1)	0.141	0.181	0.233	0.252	0.229	0.240	0.213
TSS	mg/L	421	207	213	281	239	214	265
	lbs/day	275	143	155	170	154	140	173
	lbs/capita/day(1)	0.374	0.195	0.212	0.232	0.209	0.191	0.236
Total Phosphorus	mg/L	5.93	5.96	6.45	8.67	6.88	6.33	6.72
	lbs/day	3.87	4.12	4.71	5.25	4.41	4.13	4.42
	lbs/capita/day(1)	0.0053	0.0056	0.0064	0.0071	0.0060	0.0056	0.0060

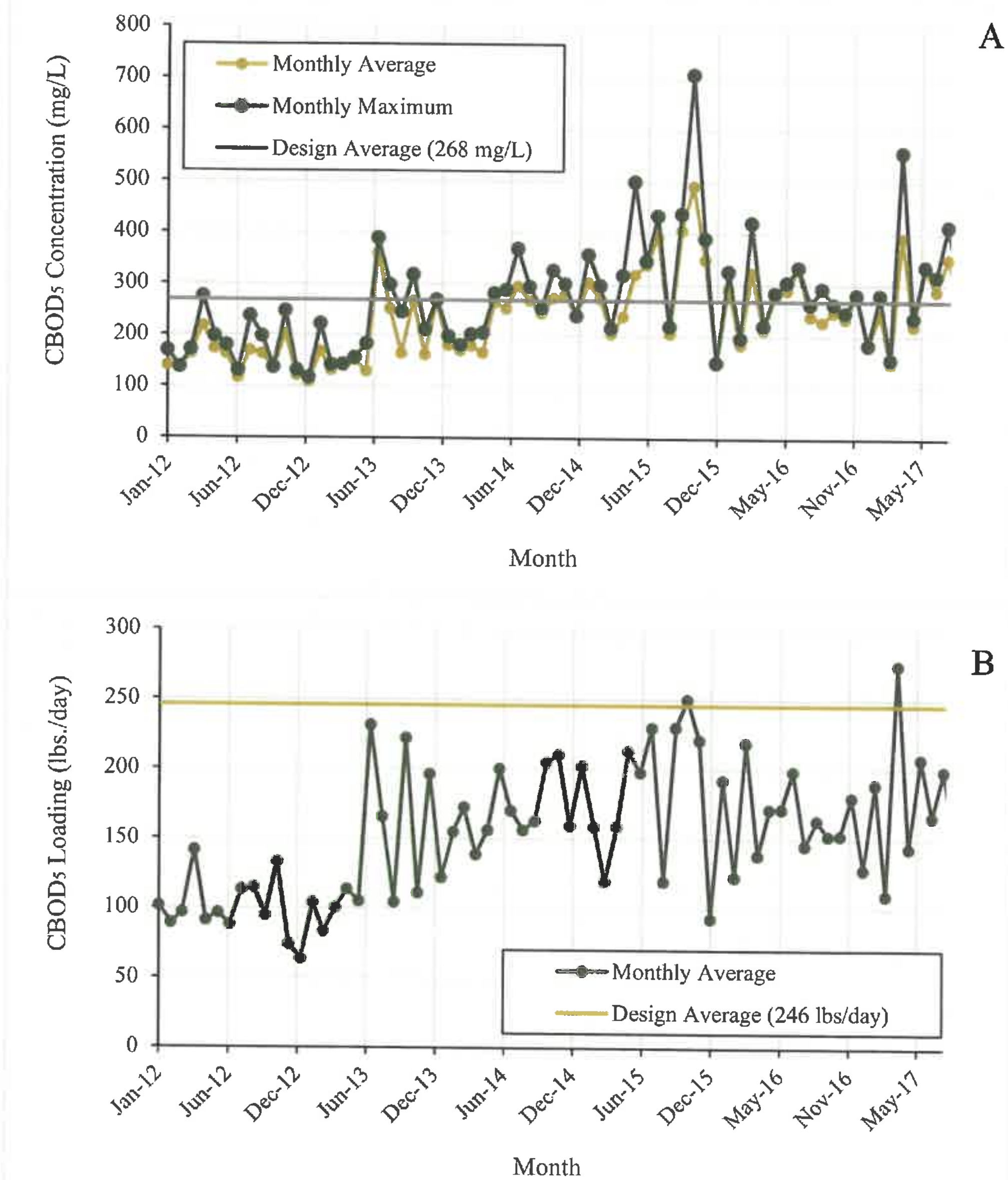


Figure 3.3 – Historical Influent CBOD5 Concentration (A) and Mass Loading (B) at Wastewater Treatment Facility

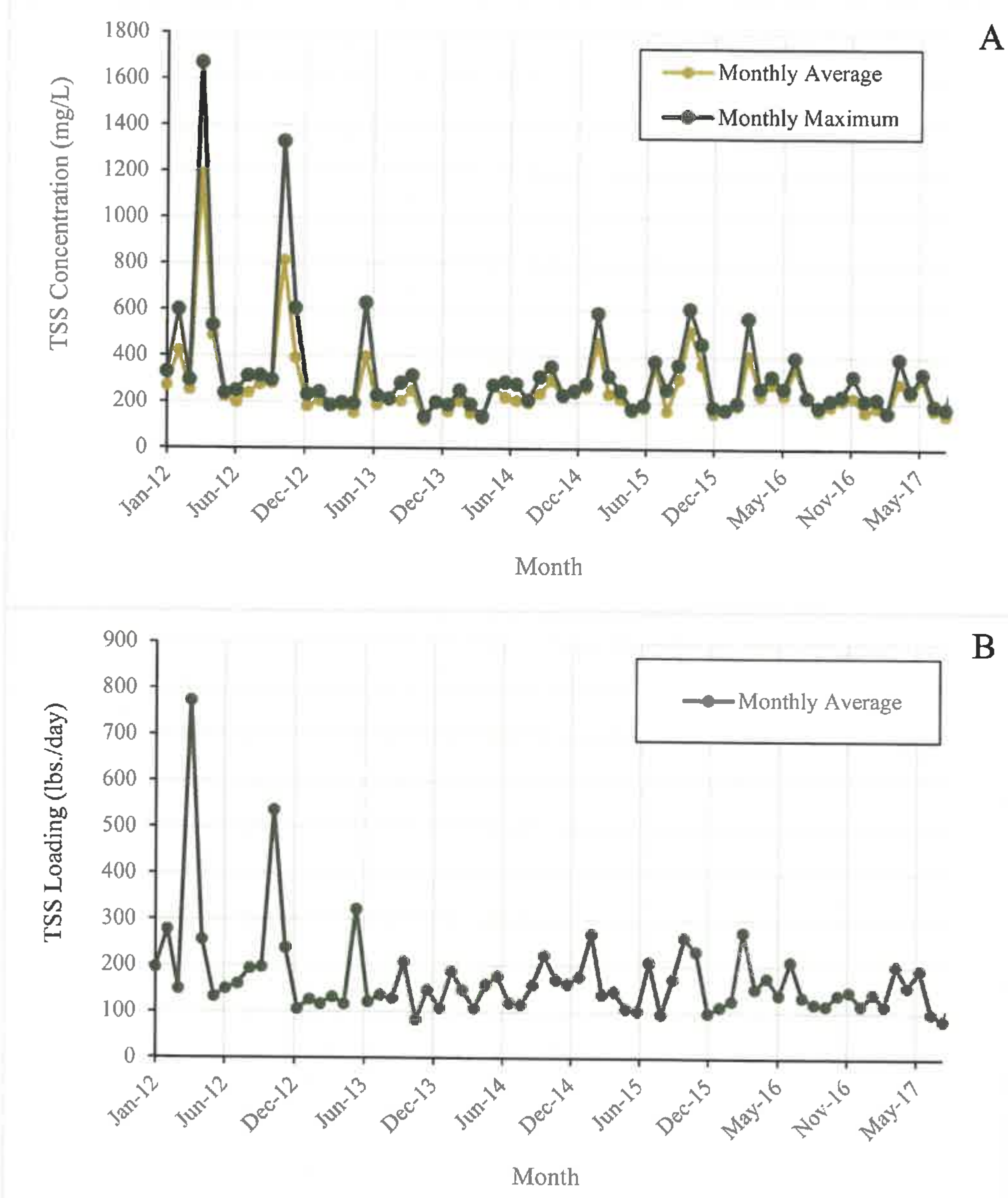


Figure 3.4 – Historical Influent TSS Concentration (A) and Mass Loading (B) at Wastewater Treatment Facility

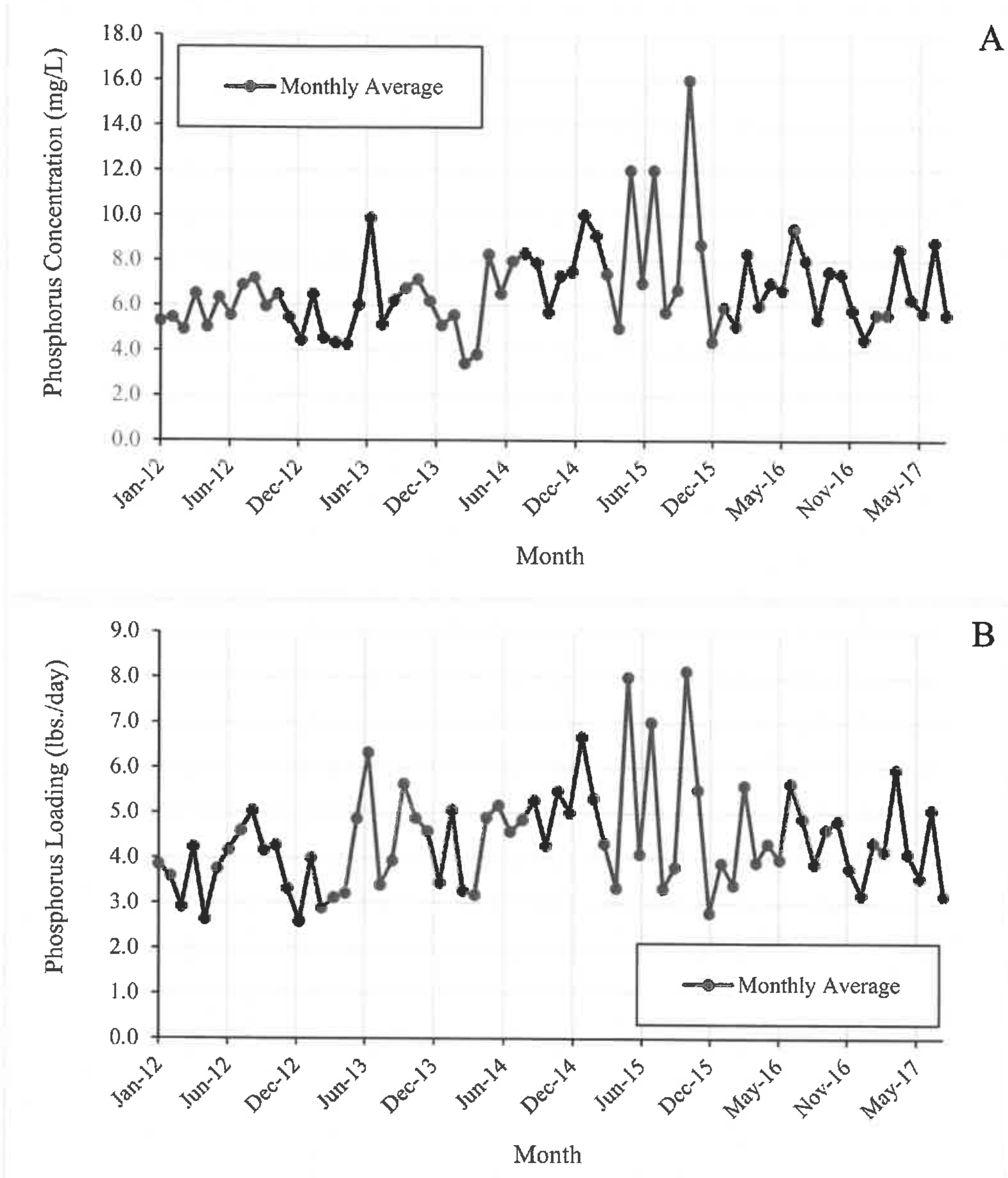


Figure 3.5 – Historical Influent TP Concentration (A) and Mass Loading (B) at Wastewater Treatment Facility

b) Industrial Loads

The City of Lanesboro does not have any significant industrial users (SIUs) that discharge to the treatment system. Based on discussions with City staff, there are no plans to provide sanitary service to any existing or new industrial users over the 20-year design period. Thus, provisions for future industrial growth are not considered in the design loading criteria.

C. DESIGN FLOWS AND LOADINGS

1. Design Flows

a) Climatic Conditions

The MPCA has guidelines for determining design wastewater flows for new or expanded treatment facilities. Flow projections are developed for different climatic conditions as described below.

- *Average Dry Weather (ADW) Flow* – Measure of flow during which there is no inflow due to precipitation and/or snow melt and no infiltration due to high groundwater. This flow typically occurs during winter months or very dry summers. It is also strongly correlated with drinking water usage.
- *Average Wet Weather (AWW) Flow* – Daily average flow for the wettest 30 consecutive days for mechanical treatment facilities. AWW flow is based on flow with infiltration due to high groundwater and typical inflow due to precipitation and/or snow melt. This flow typically occurs during the spring and early summer.
- *Peak Hourly Wet Weather (PHWW) Flow* – Peak flow during the peak hour of the day at a time when the groundwater is high and a five-year, one-hour storm event is occurring.
- *Peak Instantaneous Wet Weather (PIWW) Flow* – Peak instantaneous flow during the day at a time when the groundwater is high and a 25-year, one-hour storm event is occurring. This flow is used for sizing pumps and piping systems.

b) Average Dry-Weather Base Flow

The average dry-weather (ADW) base flow is measured as the residential/commercial design flow when the groundwater table is at normal level and a runoff condition is not occurring. Based on historical monitoring data, the minimum 180-day rolling average is used to describe yearly dry-weather flows, which was calculated as 98 gpcd. Since this closely follows the design value of 100 gpcd provided by Ten State Standards, a value of <u>100 gpcd</u> is used for the analysis.

c) MPCA Design Flow Determination

Design flow parameters were determined by following the procedures outlined in the MPCA document "*Design Flow and Loading Determination Guidelines for Wastewater Treatment Plants*," which is included in Appendix E of this report. Based on these guidelines, a detailed breakdown of the design flow analysis for the City of Lanesboro's wastewater treatment facility is presented in Table 3.3.

Table 3.3 – Determination of 20-Year Design Flows			
A)	**For Determination of Peak Hourly Wet Weather Design Flow (PHWW)**		**gpd**
1	Present peak hourly dry weather flow		83,500
2	Present peak hourly flow during high ground water period (no runoff)		172,500
3	Present peak hourly dry weather flow [same as (1)]	-	83,500
4	Present peak hourly infiltration	=	89,000
5	Present hourly flow during high ground water period and runoff at point of greatest distance between Curves Y and Z		N/A
6	Present hourly flow during high ground water (no runoff) at same time of day as (5) measurement	-	N/A
7	Present peak hourly flow	=	N/A
8	Present peak hourly inflow adjusted for a 5-year 1-hour rainfall event		72,500
9	Present peak hourly infiltration [same as (4)]		89,000
10	Peak hourly infiltration cost effective to eliminate	-	0
11	Peak hourly infiltration after rehabilitation (where rehabilitation is cost effective)	=	89,000
12	Present Peak hourly adjusted inflow [same as (8)]		72,500
13	Peak hourly inflow cost effective to eliminate	-	0
14	Peak hourly inflow after rehabilitation (where rehabilitation is cost effective)	=	72,500
15	Population increase of 0 @ 100 gpcd		0
16	Peak hourly flow from planned industrial increase		0
17	Estimated peak hourly flow from future unidentified industries		0
18	Peak hourly flow from other future increases		0
19	Peak hourly wet weather design flow [(1)+(11)+(14)+(15)+(16)+(17)+(18)]		***245,000***
B)	**For Determination of Peak Instantaneous Wet Weather Design Flow (PIWW)**		**gpd**
20	Peak hourly wet weather design flow [same as (19)]		245,000
21	Present peak hourly inflow adjusted for a 5-year 1-hour rainfall event [same as (8)]	-	72,500
22	Present peak inflow adjusted for a 25-year 1-hour rainfall event	+	117,500
23	Peak instantaneous wet weather design flow	=	***290,000***
C)	**For Determination of Average Dry Weather Design Flow (ADW)**		**gpd**
24	Present average dry weather flow		75,500
25	Population increase of 0 @ 100 gpcd	+	0
26	Average flow from planned industrial increase	+	0
27	Estimated average flow from other future unidentified industries	+	0
28	Average flow from other future increases	+	0
29	Average dry weather design flow [(24)+(25)+(26)+(27)+(28)]	=	***75,500***
D)	**For Determination of Average Wet Weather Design Flow (AWW)**		**gpd**
30	Present average dry weather flow		75,500
31	Average infiltration and inflow after rehabilitation (where rehabilitation is cost effective)	+	34,500
33	Population increase of 0 @ 100 gpcd	+	0
34	Average flow from planned industrial increase	+	0
35	Estimated average flow from future unidentified industries	+	0
36	Average flow from other future industries	+	0
37	30-day average wet weather design flow [(30)+(31)+(32)+(33)+(34)+(35)+(36)]	=	***110,000***

2. Design Loadings

a) Residential and Commercial Design Loadings

(1) Annual Average Loadings

Average design loadings from residential and commercial users are calculated by determining mass per capita (e.g. lbs/capita/day) values for $CBOD_5$, TSS, Total Kjeldahl Nitrogen (TKN), and total phosphorus. As previously discussed, common per capita design loading rates, given by the *Recommended Standards for Wastewater Facilities – 2014 Edition*, are 0.17-0.22 lbs. CBOD5/capita/day, 0.20-0.25 lbs. TSS/capita/day, and 0.036-0.046 lbs. TKN/capita/day. A common loading for total phosphorus, according to Metcalf & Eddy (2003), is 0.008 lbs. TP/capita/day.

Table 3.2 indicates that Lanesboro's wastewater falls within these ranges for $CBOD_5$ and TSS on an average basis. As a conservative measure, the design values use the high-end value of the typical ranges. Total phosphorus is characterized by the historical average of 0.006 lbs./capita/day. No monitoring data is available to determine TKN, therefore a design value of 0.036 lbs/ TKN/capita/day is used.

Table 3.4 summarizes average design loadings for residential and commercial users in Lanesboro.

Table 3.4 – Residential & Commercial Average Loadings

Parameter	Per Capita Design Loading	Average Loading
Design Population	-	755
$CBOD_5$	0.22 lbs./capita-day[1]	166 lbs./day
TSS	0.25 lbs./capita-day[1]	189 lbs./day
TKN	0.036 lbs./capita-day[1]	27.2 lbs./day
TP	0.006 lbs./capita-day[2]	4.5 lbs./day

(1) Design value per Ten State Design Standards
(2) Based on historical loading rates for phosphorus

(2) Seasonal Loadings

Historical monitoring data reflects seasonal increases in wastewater loadings that exceed the average values summarized in Table 3.4 above. The wastewater treatment facility must have sufficient capacity to treat seasonal spikes in pollutant loadings that are sustained on a monthly basis. In order to account for seasonal loadings, peaking factors can be calculated based on ratios of historical average (50th percentile) and seasonal loadings (95th percentile). Peaking factors are applied to the values in Table 3.4 to determine 20-year design loadings.

Table 3.5 – Residential & Commercial Seasonal Loadings

Parameter	Historical Average	Historical 95th Percentile	Calculated Peaking Factor
CBOD5 (lbs/day)	156	231	1.48
TSS (lbs/day)	173	300	1.73
TKN (lbs/day)	27.2	--	1.50
TP (lbs/day)	4.4	6.8	1.55

b) Industrial Loadings

The City of Lanesboro does not have any significant industrial users (SIUs) that discharge to the treatment system. Based on discussions with City staff, there are no plans to provide sanitary service to any existing or new industrial users over the 20-year design period. Thus, provisions for future industrial growth are not considered in the design loading criteria.

The existing wastewater facility included capacity for a small cheese plant that discontinued operation years ago.

c) 20-Year Design Loadings

Table 3.6 summarizes the calculated 20-year design loadings, which includes all residential and commercial sources, including peaking factors for seasonal loadings that reflect historical values.

Table 3.6 – 20-Year Design Loadings				
User	$CBOD_5$ (lbs/day)	TSS (lbs/day)	TKN (lbs/day)	TP (lbs/day)
Residential & Commercial				
Annual Average	166	189	27.2	4.5
Seasonal Peaking Factor[(1)]	x1.48	x1.73	x1.50	x1.55
Industrial Contributions	--	--	--	--
20-Year Design Loading	246	327	40.8	7.0

(1) Seasonal peaking factors based on historical values in Table 3.5

3. Summary of Design Criteria

Table 3.7 summarizes the 20-year design flows and loadings to the Lanesboro Wastewater Treatment Facility, which closely resemble the existing design parameters. The City of Lanesboro is not expecting any residential or commercial growth over the next 20 years that would account for additional flows and loadings beyond the existing parameters. Historical monitoring data supports these findings.

These values will be utilized in subsequent sections to evaluate the existing treatment system and to determine improvement alternatives.

Table 3.7 – Summary of Design Parameters		
Parameter	Existing	20-Year Design
Design Flow (MGD)		
ADW	0.101	0.076
AWW	0.110	0.110
PHWW	0.245	0.245
PIWW	0.290	0.290
Design Loading (lbs/day)		
$CBOD_5$	246	246
TSS	--	327
TKN	--	40.8
TP	--	7.0

D. BIOSOLIDS

The City of Lanesboro's existing wastewater treatment facility produces biosolids that are injected into nearby agricultural fields in October and April/May each year. Biosolids removed from the treatment process are stored in a non-aerated cold storage tank and periodically transferred to the sludge drying beds for dewatering. Table 3.8 summarizes biosolids production and sampling results over the past five years. The dewatered solids have averaged 45 percent concentration, while ranging from 26 to 67 percent. This wide range is likely due to exposure to precipitation because the drying beds are not covered. The operators have also observed poor drainage at times, which may indicate temporary clogs in the sand layers or drain line back to the treatment facility. Appendix C includes Lanesboro's Annual Biosolids Reports submitted to the MPCA.

Biosolids production is impacted by a number of variables including the amount of $CBOD_5$ and TSS loadings entering the facility, the amount removed in the treatment process, and the type of biological treatment process. Inert solids such as sand and grit are removed at the headworks of facility in the screening and grit removal processes. Dense non-soluble organic solids are removed in the Primary Clarifiers, while the remaining solids and soluble organics are removed in the biological treatment system and clarification processes. Solids production can vary significantly based on the type of biological treatment processes utilized. In any biological system, the internal growth of bacteria and microorganisms needed to treat the wastewater contributes towards the overall solids production. Lanesboro currently utilizes a single-stage trickling filter process for biological treatment. If Lanesboro moves to an activated sludge–based system, biosolids production is expected to increase.

Table 3.8 – Historical Annual Biosolids Production

Parameter	2012	2013	2014	2015	2016	Average
Wet Weight (tons)	86.67	42.00	25.80	29.00	29.50	42.59
Dry Weight (tons)	22.62	19.32	12.40	19.60	11.50	17.09
Total Solids (%)	26.1	46.3	48.1	67.1	39	45
Total Volatile Solids (%)	74.25	71.00	65.30	74.30	63.40	69.65
Kjeldahl Nitrogen (%)	7.59	1.64	1.49	4.56	0.78	3.21
Ammonia Nitrogen (%)	0.590	0.396	0.392	0.365	0.227	0.394
Phosphorus (%)	0.970	0.439	0.272	0.107	0.067	0.371
Potassium (%)	0.120	0.101	0.099	0.082	0.015	0.083
pH	6.10	7.25	6.77	6.70	6.81	6.73
Arsenic (mg/kg)	0.19	3.46	5.35	3.60	0.68	2.66
Cadmium (mg/kg)	2.70	2.53	4.90	2.58	0.46	2.63
Copper (mg/kg)	1582	593	837	528	93.4	727
Lead (mg/kg)	65.9	50.6	61.8	30.8	7.2	43.3
Mercury (mg/kg)	1.88	0.94	1.20	0.84	0.73	1.12
Molybdenum (mg/kg)	5.58	4.78	7.61	4.23	1.73	4.79
Nickel (mg/kg)	26.1	15.8	24.5	12.2	2.8	16.3
Selenium (mg/kg)	1.04	4.65	6.96	5.37	1.02	3.81
Zinc (mg/kg)	1977	958	1560	849	163	1,101
Volume @ 2.5% Solids (gal)	216,824	186,393	118,950	186,517	110,277	185,028
6-month Storage Volume (gal)	108,412	93,196	59,475	93,259	55,138	92,514

4. EXISTING WASTEWATER FACILITIES

A. GENERAL

This section evaluates the condition and financial status of the existing treatment system, including a discussion on NPDES discharge permit requirements, historical treatment performance, and future considerations.

B. OVERVIEW OF SYSTEM

The City of Lanesboro owns and operates a Class C wastewater treatment facility that treats domestic wastewater generated by residents and businesses throughout the city, as well as seasonal usage generated by tourism. The facility continuously discharges treated effluent to the South Branch of Root River (SD001) in accordance with National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit No. MN0020044. Root River is designated as a Class 1B, 2A, 3B, 4A, 4B, 5, 6 surface water suitable for domestic consumption, aquatic life, and recreation.

1. History

The Lanesboro Wastewater Treatment Facility was originally constructed in 1938 as a single-stage, attached-growth trickling filter process. The facility has received minor upgrades over the years to maintain the aging treatment processes. A timeline of major upgrades (on record) is summarized in the following bullet points:

- *1938* – Construction of the original treatment facility, including the influent pump station, operations building, primary clarifier, trickling filter, final clarifier, chlorine contact tank, and sludge storage and drying beds.
- *1997/1998* – Replacement of the primary and secondary clarifier sludge collection mechanisms, installation of mechanical bar screen, and replacement of trickling filter distribution arm and media.

Other improvements may have occurred over the years between 1938 and 1998, but no records are available for documentation. Minor improvements over the years likely included replacement of pumps, chemical feed equipment, and other mechanical components. The buildings, tanks, and infrastructure are all original to the 1938 construction project.

2. Process Description

The Lanesboro Wastewater Treatment Facility utilizes a combination of physical, chemical, and biological treatment processes to produce treated effluent that complies with NPDES discharge permit requirements. The facility is equipped with a single-stage trickling filter for attached-growth biological treatment, which removes soluble organics from the liquid wastewater stream. Suspended solids that enter the facility are removed in the primary clarifiers, while solids generated in the biological system are removed in the secondary clarifiers. The facility is classified as a Class C treatment facility with Type IV biosolids land application. Figure 4.1 illustrates a general process flow diagram for the existing facility.

a) Preliminary Treatment

Raw wastewater generated throughout the Lanesboro service area is conveyed to the treatment facility via a 12-inch vitrified clay (VCP) interceptor sewer. Raw wastewater flows through an influent manhole and is directed to the lower structure of the Operations Building, where it flows through a mechanical bar screen before dumping into the raw pumping station. The mechanical bar screen is used to remove large solids (1.5" or larger) such as sticks, rags, and other debris that finds its way into the collection system. The screened wastewater flows into the pumping station, where it is temporarily stored and then pumped to the Primary Clarifiers.

b) Primary Treatment

The facility's primary treatment system consists of a single rectangular Primary Clarifier, where less dense suspended solids are given time to settle and are removed from the wastewater by a submerged sludge mechanism. The sludge mechanism conveys settled solids to a sump that is periodically pumped out by the sludge transfer pump located in the Operations Building. As the mechanism rotates, it also skims the surface to remove floating solids (or scum) such as oil and grease, which are discharged into a scum beach. The clarified liquid overflows into the effluent launders and into a dosing chamber that is equipped with a dosing siphon. The dosing siphon is used to ensure a constant flow rate and velocity are being applied to the trickling filter.

The Primary Clarifiers are typically designed to remove approximately 25 and 50 percent of the influent organics and suspended solids, respectively. This reduces the loading to the biological treatment system and helps eliminate issues with solids accumulation in the trickling filters.

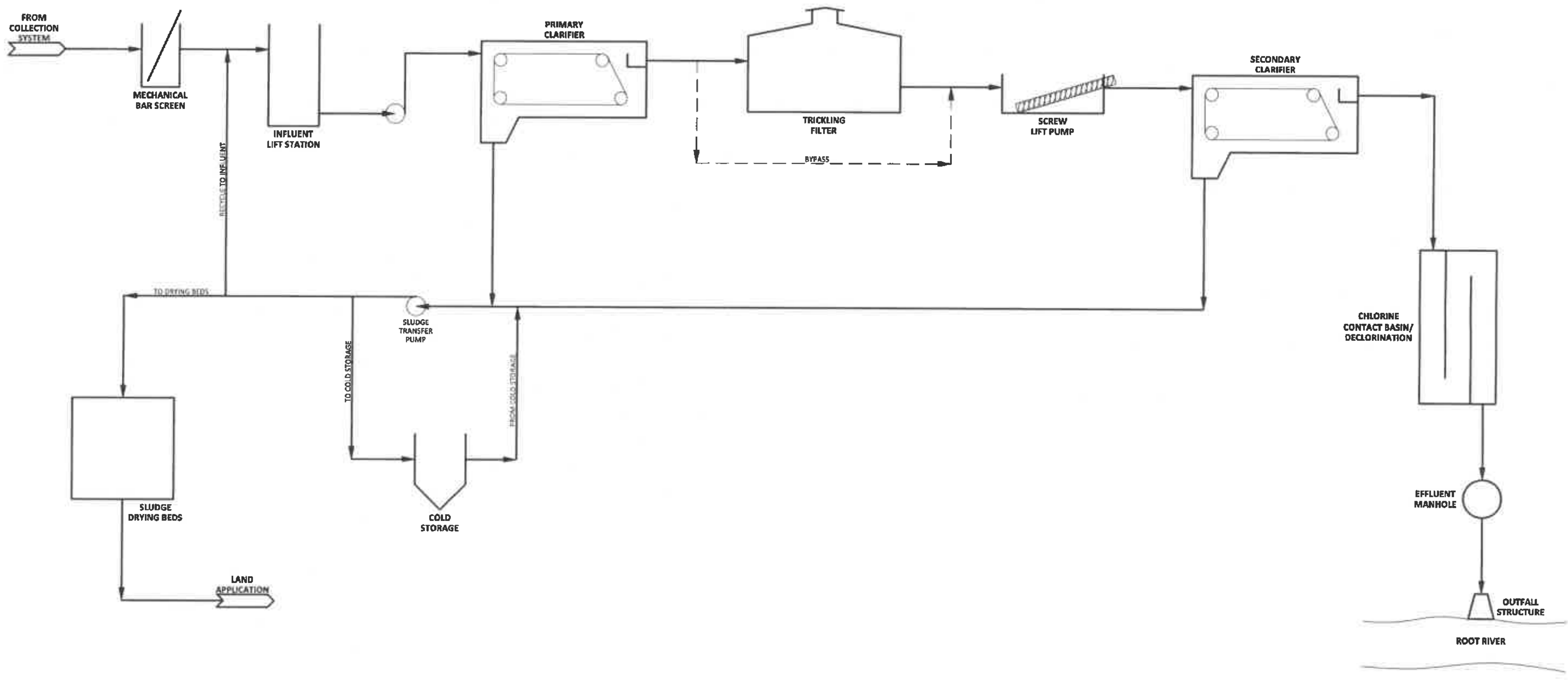
c) Secondary Treatment

The secondary treatment system consists of a single-stage trickling filter. Trickling filters are an attached-growth biological treatment process that use internal media to promote the growth of microorganisms. As wastewater "trickles" downward through the filter media, the microorganisms metabolize organics and some nutrients in the wastewater. The attached microorganisms are mainly aerobic bacteria and protozoans that need oxygen to survive. Natural circulation of air through the trickling filters provides a sufficient supply of oxygen for the bacteria, which makes the trickling filter an extremely efficient process since little external energy is required.

Wastewater that travels through the media is collected at an underdrain and is conveyed to the effluent box. From the effluent box, wastewater flows by gravity to an intermediate screw lift station that lifts the water to the Secondary Clarifier. In the Secondary Clarifier, suspended solids and sloughed-off biological film from the trickling filter are allowed to settle and are removed from the liquid process stream. Similar to the Primary Clarifier, a submerged sludge mechanism is used to collect settled and floating solids. Settled solids are periodically pumped out by the sludge transfer pump in the Operations Building. The clarified liquid overflows into the effluent launders and flows by gravity to the disinfection basin for final treatment.

d) Disinfection

The disinfection system consists of a chlorine gas feed system and baffled concrete contact tank. Sulfur dioxide gas is dosed to dechlorinate the water prior to discharge to the river. The gas feed and storage systems are housed under a lean-to style shed located adjacent to the tank. The facility uses 150 lbs. pressurized cylinders to store chlorine and sulfur dioxide gas. Submersible ejector pumps located inside the contact basin are used in combination with venturi ejector assemblies to draw the gases under vacuum into solution. The chemical solutions are pumped to a submerged diffuser that disperses the solution into the contact tank.



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PRELIMINARY ENGINEERING REPORT
PROCESS FLOW DIAGRAM
EXISTING FACILITIES

FIGURE 4.1

A cylinder-mounted chlorinator and rotameter allow the operators to manually select the chemical dosing rate to achieve proper disinfection and dechlorination. The chlorine contact basin provides sufficient detention time to allow the chlorine to react and kill residual microorganisms. Sulfur dioxide is dosed to dechlorinate the water prior to discharge to the Root River.

e) Biosolids Processing

A beneficial byproduct of the wastewater treatment process is the production of biosolids, which is the stabilized form of wastewater sludge that is applied to agricultural fields in the fall and spring. Solid byproducts are derived from various sources throughout the treatment process and include both inorganic and organic components. Much of the inorganics are removed in the screening process, which are inert and cannot be processed further. The organic portion of solids are both natural in the raw wastewater and created in the biological treatment process as part of microbial metabolism. These solids are removed in the Primary and Secondary Clarifiers and transferred to the sludge processing system.

The facility's sludge processing system consists of a single sludge transfer pump, sludge storage tank, and dual drying beds. The 25,000 gallon storage tank serves as cold storage and decanting prior to application to the drying beds. Solids are transferred from the storage tank to the drying beds via the operation of the sludge transfer pump. The purpose of the drying beds is to dewater the biosolids through gravity filtration and evaporation. If working properly, this significantly reduces the volume of biosolids that ultimately is hauled and applied to local agricultural fields.

C. NPDES DISCHARGE PERMIT AND FUTURE REGULATIONS

1. Existing Permit

The treatment facility's effluent discharge is monitored and regulated in accordance with NPDES/SDS Permit No. MN0020044. Lanesboro is in the process of renewing their permit as the current permit expired on November 30, 2016. The facility is allowed to operate in accordance with their existing permit until the new permit is issued. A copy of the current permit is included in Appendix A. A summary of the current effluent limits is presented in Table 3.9 below.

Table 3.9 – NPDES Discharge Limits-Worthington, MN

Parameter	Season	Limit Type	Limits
$CBOD_5$	Jan. - Dec.	Monthly Ave.	25 mg/L (10 kg/day)
	Jan. - Dec.	Max Week Ave.	40 mg/L (17 kg/day)
	Jan. - Dec.	Min. Monthly Ave.	85% Removal
TSS	Jan. - Dec.	Monthly Ave.	30 mg/L (12 kg/day)
	Jan. - Dec.	Max Week Ave.	45 mg/L (19 kg/day)
	Jan. - Dec.	Min. Monthly Ave.	85% Removal
Fecal Coliform	May - Oct.	Monthly Ave. (Geometric)	200 #/100 mL
Total Residual Chlorine	Jan. - Dec.	Daily Max	0.038 mg/L
pH	Jan. - Dec.	Monthly Min.	6.0
	Jan. - Dec.	Monthly Max	9.0
NH_3-N & TKN	Apr. Sept.	Monitor Only	
Total Phosphorus	Jan. - Dec.	Monitor Only	

2. **Proposed Limits**

The existing facility's NPDES/SDS permit reissuance has not been finalized at the time of this report. However, correspondence and documentation from the MPCA suggests that Lanesboro will not receive any new pollutant limits in their upcoming 5-year permit renewal. The facility will be required to conduct additional monitoring for nitrogen compounds in response to the Minnesota Nutrient Reduction Strategy, as well as total dissolved solids. Refer to Appendix B to review the Effluent Limitations Summary provided by the MPCA.

3. **Future Considerations**

a) Phosphorus Limits

The Effluent Limitations Summary provided by the MPCA for the upcoming permit renewal (see Appendix B) provides insight into the rationale behind phosphorus monitoring and limitations. The Root River currently does not exceed the response variable set forth by River Eutrophication Standards (RES) that would trigger a phosphorus limit for the Lanesboro wastewater treatment facility. However, the City will be required to complete a phosphorus management plan to identify ways to reduce phosphorus discharge through source management or treatment strategies.

Over the next few permitting cycles, there is a potential for the Lanesboro wastewater treatment facility to receive a phosphorus limit as the MPCA continues to evaluate the impacts of nutrients on rivers and streams. Based on historical treatment performance discussed in subsequent paragraphs, the existing facility would not be able to meet a phosphorus limit without significant process modifications or addition of chemical feed (e.g. ferric chloride or alum).

b) Nitrogen Limits

The Effluent Limitations Summary provided by the MPCA for the upcoming permit renewal is proposing additional monitoring requirements for nitrogen compounds including ammonia-N, total Kjeldahl nitrogen, and nitrate + nitrite. Over the next few permitting cycles, there is a potential for the facility to receive limits in response to further developments in the Minnesota Nutrient Reduction Strategy.

Based on historical treatment performance and process limitations, the existing facility would have difficulty meeting ammonia-N limits during cold weather months in the winter and early spring. The facility would not be able to meet total nitrogen limits in any scenario due to technological limitations of the existing plant.

c) Preliminary Effluent Limits Request

If the City were to construct a new treatment facility with alternative treatment technologies such as activated sludge, it is unlikely these improvements would trigger immediate limits for phosphorus or nitrogen. In order to evaluate this potential, a Preliminary Effluent Limit Review Request (PELRR) has been sent to the MPCA for review of potential permit requirements if the City decided to significantly alter the existing treatment process. A copy of this request is included in Appendix D.

D. TREATMENT PERFORMANCE

The treatment facility's NPDES permit specifies pollutant discharge limits for $CBOD_5$, TSS, pH, and fecal coliform. The facility also monitors total phosphorus and nitrogen compounds (TKN, ammonia-N, and nitrate+nitrite). Figures 4.2 through 4.7 show reported effluent discharge values for each of these pollutants since January 2012 (to present). Over this timeframe, the facility has met nearly all discharge requirements. In January 2014, the facility appears to have exceeded concentration and loading limits for $CBOD_5$, while fecal coliform was exceeded in August 2013.

Effluent phosphorus concentration has ranged from 2.00 to 6.80 mg/L, with an average value of 4.76 mg/L. The facility is not equipped to remove phosphorus and would not meet limits if imposed in the next few permitting cycles. The facility would also have difficulty meeting ammonia-N limits during the winter and early spring season.

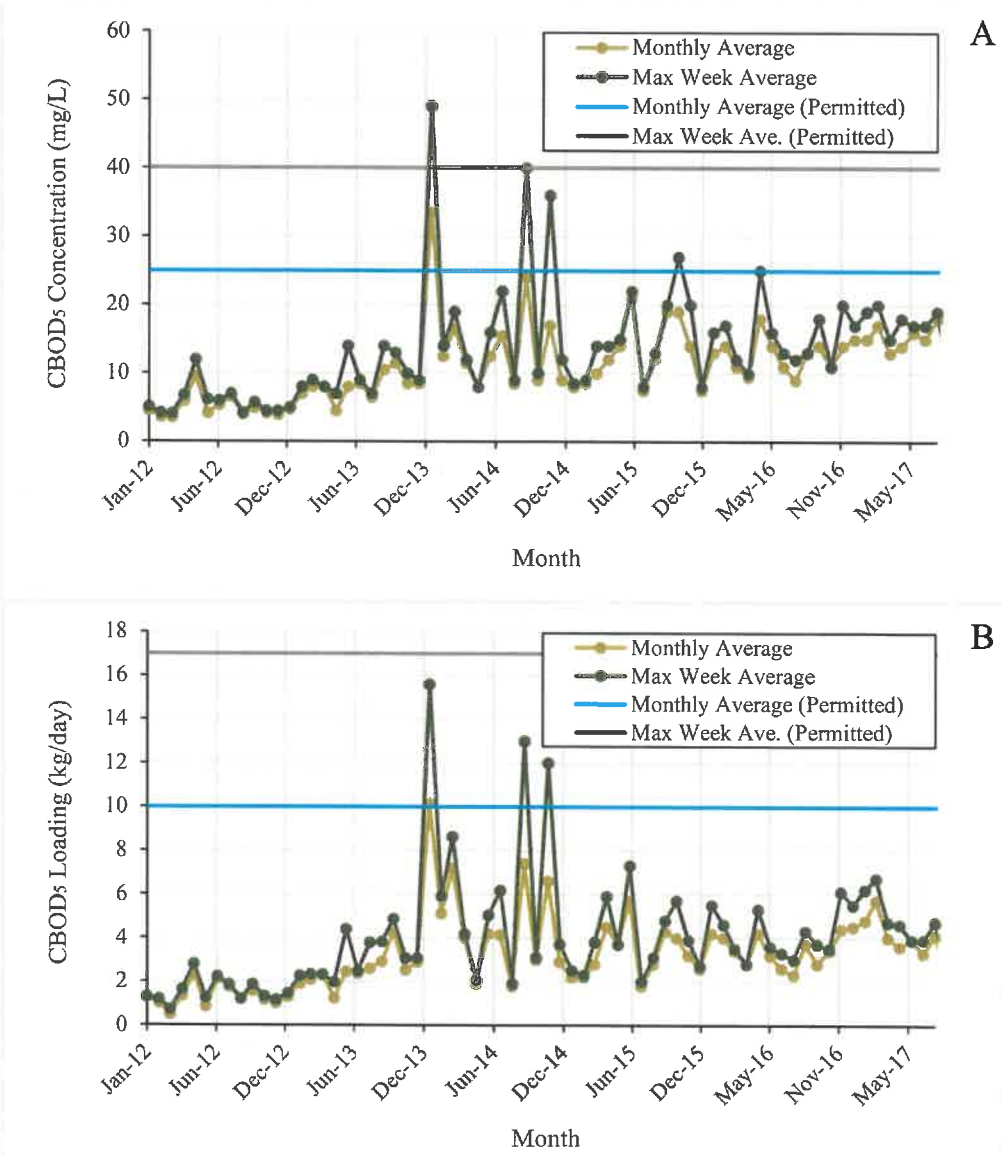


Figure 4.2 – Historical Effluent $CBOD_5$ Concentration (A) and Mass Loading (B) at Wastewater Treatment Facility

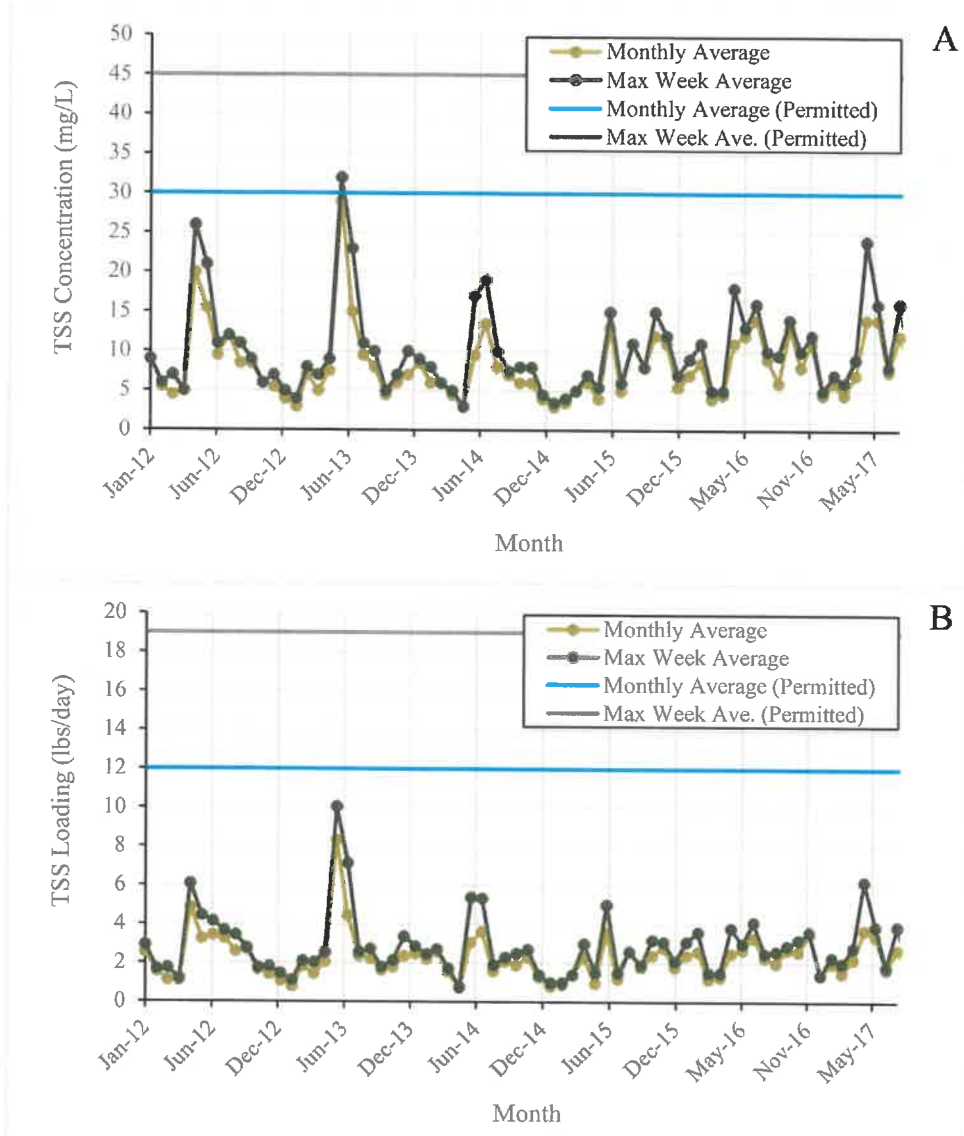


Figure 4.3 – Historical Effluent TSS Concentration (A) and Mass Loading (B) at Wastewater Treatment Facility

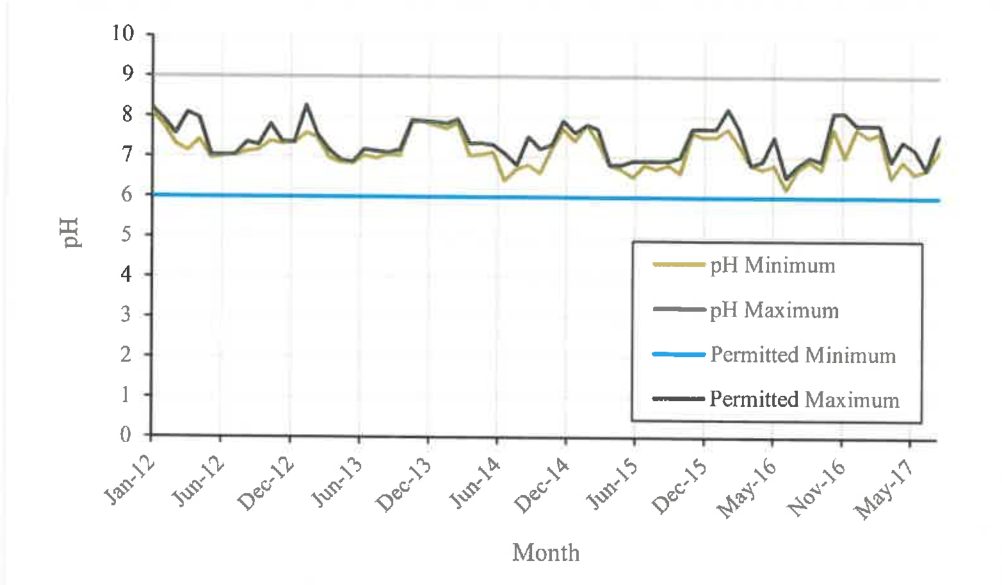


Figure 4.4 – Historical Effluent pH Values

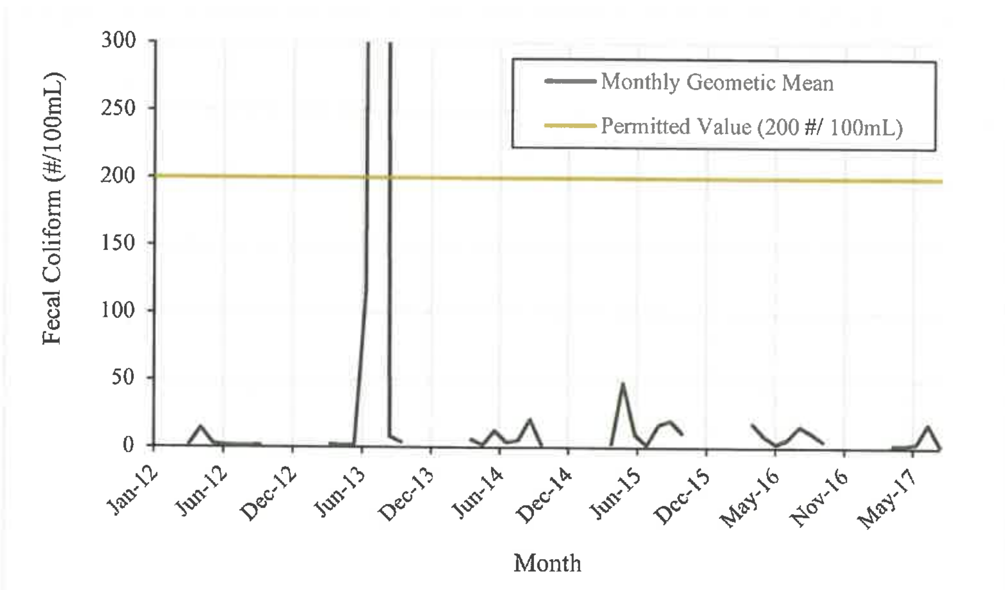


Figure 4.5 – Historical Effluent Fecal Coliform Values

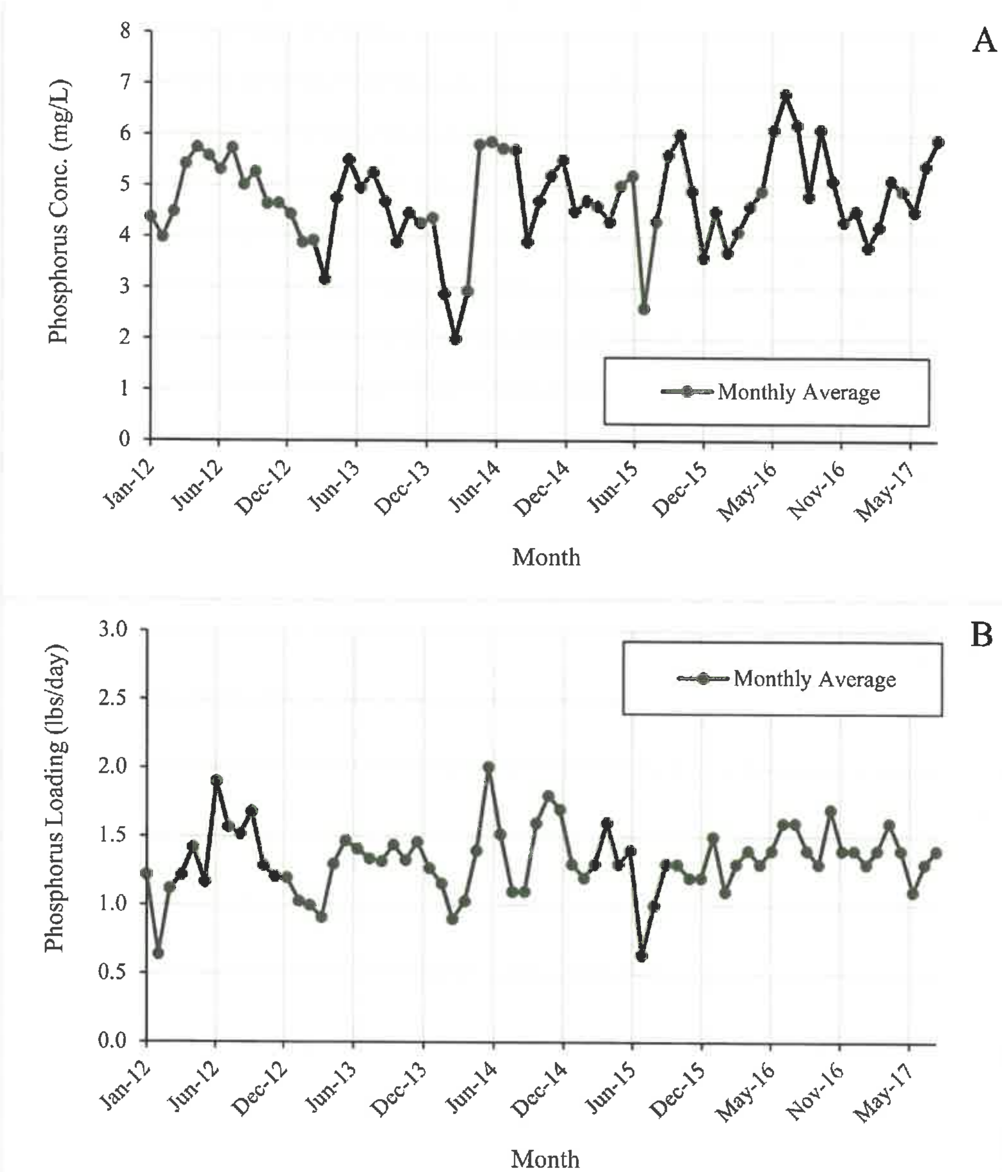


Figure 4.6 – Historical Effluent TP Concentration (A) and Mass Loading (B) at Wastewater Treatment Facility

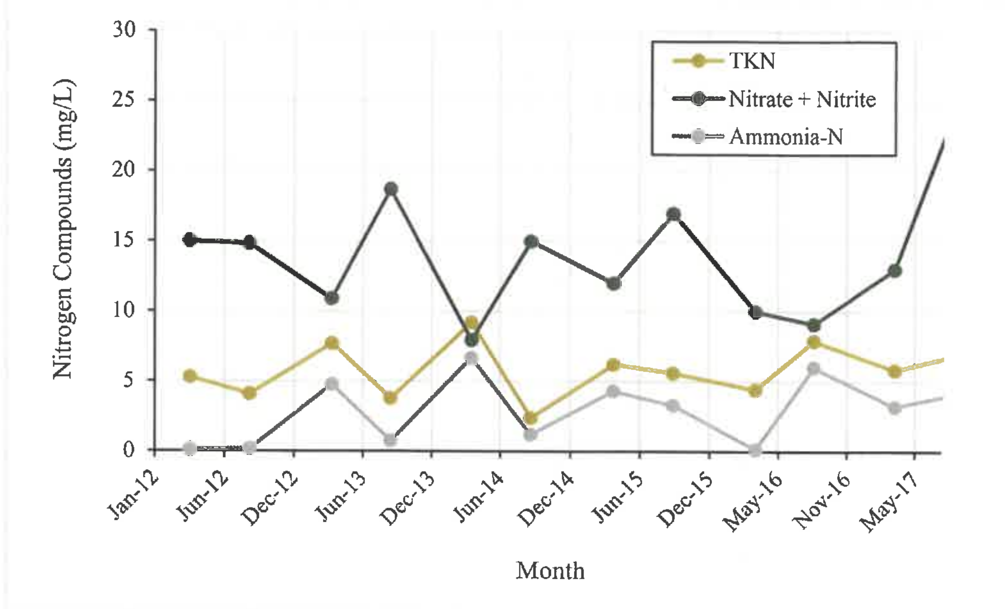


Figure 4.7 – Historical Effluent Nitrogen Compound Concentrations

E. EXISTING CONDITION

1. Collection System

a) Gravity Sewer System

The City has approximately 36,000 lineal feet of sanitary mainline pipe. Of that, approximately 28,500 lineal feet (or 79%) is vitrified clay pipe (VCP) ranging in diameter between 8 and 12 inches. The remainder of the collection system is newer PVC pipe.

The City has not recently completed any televising inspections of mainline sewer or performed a conditional inventory of manhole structures. Generally speaking, VCP is susceptible to infiltration through deteriorated joints as well as cracks and broken pipe segments. For this reason, infiltration of groundwater into VCP sanitary mains and services is expected to be a significant source of clear-water into the system.

According to the analysis in Section 3, the existing collection system exceeds MPCA threshold values of excessive infiltration and inflow by nearly 20 percent. Options to reduce infiltration and inflow are discussed in the alternatives analysis in Section 5.

b) Sanitary Lift Stations

The City of Lanesboro does not have any sanitary lift stations.

2. Wastewater Treatment System

a) Preliminary Treatment

(1) Mechanical Bar Screen

The mechanical screening equipment and influent wet well are located in the Operations Building, separated from the main operating area. The screen was originally installed as part of the 1998 improvements project, being retrofitted to fit in the existing influent channel prior to flowing to the pump station wet well.

Screening equipment installed in corrosive environments typically last 20 years. The screening equipment is in fair condition for its age and may have up to another 5 years of useful life remaining (see Picture 4.1).

Picture 4.1 – Existing Mechanical Bar Screen

(2) Influent Pump Station

After wastewater is screened, it flows to the influent wet well. The wet well structure is open to the atmosphere on the west side of building, which provides a highly corrosive and potentially dangerous environment if not properly vented. The existing HVAC equipment is heavily corroded and should be replaced. The interior wet well structure is not accessible, therefore a condition assessment of the concrete could not be completed. In absence of hydrogen sulfide corrosion, concrete is expected to last 60-70 years. Based on age alone, this structure is beyond its useful life. It is difficult to speculate how long it could last, but based on corrosive area, we recommend immediate replacement.

The pump station is equipped with two (2) vertical centrifugal pumps located in the basement of the Operations Building. The pumps are dry-pit design with long shafts that extend to the floor above to allow the pumps to run if the basement area is flooded. The pumps are in poor to fair condition and are beyond their 20 year useful life. The pumps should be replaced as they become a maintenance issue. At a minimum, we recommend having spare parts and pumps on hand to ensure timely repairs and ultimately replacement is needed.

b) Primary Treatment

(1) Primary Clarifier / Building

The Primary Clarification process was originally constructed in 1938 and consists of a single rectangular settling basin with a submerged sludge scraper/surface skimming mechanism. The rotating mechanism and drive unit were replaced in 1998 and are in generally poor condition. This equipment has a typical useful life of 20 to 25 years and should be replaced in the next 3 to 5 years.

Structurally, the exposed concrete is in poor to fair condition (see Picture 4.2). The submerged concrete could not be evaluated as the unit was in service. It appears a bituminous coating was applied to the interior submerged concrete. Concrete that remains submerged is often in better condition than concrete exposed to freeze-thaw cycles and ambient gases. Based on age alone, this structure is beyond its useful life, and needs to be replaced.

Picture 4.2 – Existing Primary Clarifier

c) Secondary Treatment

(1) Trickling Filter

The existing trickling filter was originally constructed in 1938 and received upgrades in 1998 to replace the media and radial distribution arm. The original rock media was replaced with plastic that appears to be in fair condition, although the extent of interior plugging could not be evaluated. The useful life of plastic media is typically between 20 to 30 years. Because of the age of media and concrete, replacement is recommended as soon as possible.

The operators did not report of any odors, which means the filters have proper ventilation to ensure anaerobic conditions are not created. These conditions can also be created when the media is plugged. Plugging can result from insufficient hydraulic loading rates or high concentrations of solids in the influent wastewater. Sufficient hydraulic loading helps avoid clogging by forcing excess biofilm to slough off the media. During winter months and low flow periods, the operators have to recycle effluent through the plant to ensure proper moisture in the trickling filter. Based on these observations and the facility's historical performance, the trickling filter system is well operated and maintained by City staff. The radial distribution arm is steel construction and is in poor condition due to corrosion. If the trickling filter stays in service, the distribution arm should be replaced with aluminum materials in the next 3 to 5 years, as well as the seal. However, we recommend replacing the entire structure, media, and arm since it is so old and in poor condition. The overall building structure is in generally poor condition due to age and constant exposure to moisture.

(2) Screw Lift Pump

Before flowing to the Secondary Clarifier, effluent from the trickling filter is hydraulically lifted by an existing Archimedes-style screw lift pump (see Picture 4.3). The pump is mounted in a concrete channel that is integral to the Secondary Clarifier. This style of pump typically lasts 25 to 30 years. Based on its current condition, it should last another 5 years with routine oil and maintenance.

(3) Secondary Clarifier

The Secondary Clarification process was originally constructed in 1938 and consists of a single rectangular settling basin with a submerged sludge scraper/surface skimming mechanism. The rotating mechanism and drive unit were replaced in 1998 and are in generally poor condition. This equipment has a typical useful life of 20 to 25 years and should be replaced in the next 3 to 5 years.

Structurally, the exposed concrete appears to be in good condition for its age (see Picture 4.3. There are no major signs of freeze-thaw damage or other spalling. The submerged concrete could not be evaluated as the unit was in service. However, concrete that remains submerged is often in better condition than concrete exposed to the elements. Based on age alone, this structure should be replaced.

Picture 4.3 – Existing Secondary Clarifier and Screw Pump

d) Disinfection

(1) Chlorine Contact Basin

Clarified effluent flows to the chlorine contact basin (see Picture 4.4) where it is disinfected prior to being discharged to the Root River. The chlorine contact basin was originally constructed in 1938 and consists of a baffled concrete tank. Structurally, the concrete appears to be in good condition for its age, with no major signs of freeze-thaw damage or spalled areas. Over the past few years, the City has explored options to retrofit the existing basin and install an ultraviolet (UV) disinfection system. This has a number of advantages including elimination of gas-based disinfection chemicals and associated costs and safety concerns. Because the structure is over 80 years old, it should be replaced.

Picture 4.4 – Existing Chlorine Contact Basin

(2) Chlorine and Sulfur Dioxide Feed Systems

Disinfection is required between April and October in accordance with the facility's fecal coliform limits. The facility is also required to meet a total residual chlorine (TRC) concentration of 0.038 mg/L as a daily maximum limit during this time period. In order to meet these requirements, the facility feeds chlorine gas for disinfection and sulfur dioxide gas for dechlorination. The feed systems are housed in an exterior lean-to shed located adjacent to the chlorine contact basin. Current design practices require separate enclosures for each chemical that are ventilated, heated, and have leak detection.

The existing feed systems consist of pressurized gas cylinders, weighing scale, chlorinator, and vacuum ejector. Submerged ejector pumps located inside the basin supply water to the ejectors, which creates a venturi effect that draws the gases under vacuum into the solution. The solution is fed to the basin where it is dispersed by submerged diffusers. Gas feed systems have a variety of components that typically last between 5 to 15 years before needing replacement. As previously mentioned, the City would like to replace the existing system with UV equipment, which would eliminate all chemicals and associated safety

Picture 4.5 – Chemical Feed Systems and Sampler

e) Biosolids Processing & Storage

(1) Sludge Pumping

The facility uses a single sludge pump to transfer solids between the clarifiers, cold storage tank, drying beds, and recycle to the influent. This multi-functionality is usually handled with 3 or 4 different pumps at most facilities Having a single pump creates operational limitations and a lack of redundancy in case the pump is down for maintenance.

The existing sludge pump is in generally poor to fair condition (see Picture 4.6). With routine maintenance, pumps used in sludge applications have a typical useful life of 20 to 25 years. The existing sludge pump may have another 5 years of useful life remaining. Due to its importance in the treatment process, we recommend having a spare pump in storage or, at a minimum, spare parts on hand to ensure timely repairs on this equipment. Manufacturer lead time on a replacement pump is likely 8 to 10 weeks.

Picture 4.6 – Existing Sludge Transfer Pump

(2) Sludge Storage

The existing 25,000 gallon sludge storage tank was originally constructed in 1938 and is in generally poor condition (see Picture 4.7) and must be replaced. Settled solids are transferred to the storage tank via operation of the sludge pump. The tank serves as cold storage and decanting prior to application to the drying beds. The storage tank is a pseudo-anaerobic digester that does not have mixing or proper gas draw-off equipment. Since it receives mostly primary solids that are dense and difficult to treat, the tank likely achieves minimal treatment and reduction of volatile solids.

Picture 4.7 – Existing Sludge Storage Tank

(3) Dewatering

The existing dual drying beds were originally constructed in 1938 and are in generally poor condition (see Picture 4.8). The drying beds are 18 inches in depth and provide an approximate storage capacity of 16,000 gallons of dewatered sludge. The beds are underlain by 18 inches of sand and gravel layers, with a 6-inch underdrain system that drains back to an influent manhole.

Based on recent discussions, the underdrain system is currently draining properly. However, in past years, the operators have notice temporary plugging in one of the beds. When this occurs, it does not allow the sludge to be physically dewatered by gravity. Instead, the primary dewatering mechanism is through evaporation, which is offset by precipitation and freezing during winter months. Without functioning drying beds, the facility is not in compliance with Minnesota Statute 7041.1300 for operational standards to significantly reduce pathogens.

These beds are a significant maintenance issue and may be a safety concern for operations staff in close contact with biosolids. We recommend replacement as soon as possible.

Picture 4.8 – Existing Sludge Drying Beds

f) Operation Building

The Operations Building was originally constructed in 1938 and houses the mechanical bar screen, influent pumping station, sludge pumping equipment, and electrical distribution and control system. In general, the building structure is in fair condition for its age, but could use renovations to upgrade lighting and HVAC equipment. The exterior siding and metal roofing materials appear to be in fair to good condition. The existing electrical and control equipment are obsolete and should be replaced, including general circuitry.

F. FINANCIAL STATUS

The City's wastewater system expenditures are financed through revenue generated by residential and commercial sewer fees. Sewer usage fees are calculated based on monthly metered water usage. The current rate structure for 2018 was established by City Ordinance 54.06, which includes a monthly base charge of $18.26 and usage fee of $4.70 per 1,000 gallons. These rates apply to both residential and commercial users. Table 4.1 summarizes annual budget expenditures for the wastewater system. Appendix F includes a detailed breakdown the current sewer rates and annual budget information.

Table 4.1 – Annual Expenditures and Revenues				
Item	**2015**	**2016**	**2017**	**Average**
Expenditures				
Worker Compensation & Benefits	$56,102	$40,445	$55,963	$50,837
Utilities	$11,850	$10,560	$7,512	$9,974
Maintenance, Repairs, & Services	$15,024	$17,576	$25,727	$19,443
Chemical	$21,256	$13,482	$12,114	$15,617
Supplies and Equipment	$4,569	$8,552	$3,588	$5,570
Insurance	$1,290	$1,246	$1,710	$1,415
Permit Fees & Training	$2,807	$4,756	$3,036	$3,533
Miscellaneous	$2,520	$3,916	$3,621	$3,352
Transfers	$0	$10,004	$0	$3,335
Annual Operating Expenditures	$115,418	$110,536	$113,272	$113,076
Debt Service Principal & Interest	$16,400	$81,174	$29,669	$42,414
Total Annual Expenditures	$131,818	$191,710	$142,941	$155,490
Revenues				
Residential Usage	$42,716	$42,384	$45,072	$43,391
Commercial Usage	$20,335	$18,666	$17,520	$18,840
Sewer Base Charge	$85,040	$87,727	$91,461	$88,076
Special Assessments	$23,775	$23,698	$23,684	$23,719
Connections, Penalties, Interest	$808	$2,273	$4,493	$2,525
Total Annual Revenue	$172,675	$174,748	$182,231	$176,551
+/- Operating Income	$40,857	($16,962)	$39,290	$21,061

G. WATER / ENERGY / WASTE AUDITS

No Water, energy, or waste audits have been completed as part of this project. However, completion of proposed collection system improvements is expected to reduce groundwater infiltration and inflow and, ultimately, wastewater flow to the treatment system. This has benefits in terms of reducing pumping costs and increasing the overall efficiency of the treatment process. The City's existing treatment facility utilizes an attached growth trickling filter process for biological treatment. Although this treatment technology is very energy efficient, it is not adequate to meet future treatment needs and has a number of other disadvantages discussed in Section 6 of this report. Proposed treatment alternatives require more energy intensive technologies (e.g. aeration blowers) in order to meet future treatment needs. Thus, overall operation and maintenance costs are expected to increase relative to the City's current costs.

5. PROJECT NEED

A. HEALTH, SANITATION, AND SECURITY

In general, the City of Lanesboro's existing 80 year old wastewater treatment facility has performed adequately in meeting the requirements of the facility's NPDES discharge permit. Based on historical monitoring data, the facility has exceeded limits for CBOD5 and fecal coliform once in the past six years. These individual occurrences are not considered acute health and sanitation concerns, but are indicative of an aging treatment system that lacks operational flexibility and redundancy. The fact that the facility performs as well as it does is a testament to the experience and ability of the operators. However, the facility is simply not equipped to meet more stringent discharge requirements, particularly for potential nutrient removal of phosphorus and nitrogen if imposed in the future.

As discussed in subsequent paragraphs, the City's aging collection system has issues with infiltration and inflow. The treatment facility has a designed bypass that allows the operators to discharge untreated, diluted wastewater directly to the Root River in order to avoid hydraulically overloading the system and to prevent sewage backups. The operators have been forced to use this bypass on rare occasions during extreme precipitation events.

B. AGING INFRASTRUCTURE

1. Collection System

According to MPCA criteria, the City of Lanesboro exceeds threshold values of excessive infiltration and inflow into their collection system by nearly 20 percent. Approximately 80 percent of the City's existing sewer mains are old vitrified clay pipe materials originally installed in the 1930's. Over time, VCP is susceptible to infiltration through deteriorated joints, cracks, and broken pipe segments. The following is needed in order to reduce infiltration: 1) identifying sources of infiltration through sewer televising and manhole inspections; and 2) development of an annual capital improvements plan to replace old sewer main and services. Capital improvements should focus on areas with known infiltration issues.

Sources of inflow into the sanitary collection system include potential cross-connections with residential and commercial foundation drains and sump pump discharge. Section 51.062 of the City code strictly prohibits these types of connections, although excessive inflow is still an issue.

Excessive infiltration and inflow has potential implications on wastewater treatment, especially concerning inflow during storm events that may hydraulically overload the system and impact treatment performance.

2. Wastewater Treatment

The City's existing wastewater treatment facility was originally constructed in 1938 (80 years old). Based on the evaluation presented in Section 4, most of the existing equipment is beyond its useful life and requires replacement in the next 3 to 5 years. The existing buildings and structures are original to the facility and range from poor to fair condition. This infrastructure is beyond its useful life and rehabilitation efforts.

From an operational standpoint, the facility has a number of deficiencies that includes a lack of redundancy in all unit processes and pumping equipment. In recent years, the City has explored options to renovate the solids processing system and retrofit the existing gas-based disinfection system into UV disinfection.

Overall, the facility has a number of operational and age-based issues that will require significant improvements as soon as possible.

C. REASONABLE GROWTH

The City is not expecting any significant residential, commercial, or industrial growth over the 20-year planning period. Therefore, growth is not factored into the need for improvements to the collection system and wastewater treatment infrastructure.

6. ALTERNATIVES AND COST ANALYSIS

A. GENERAL

Based on the detailed evaluation of design criteria and existing conditions presented in Sections 3 and 4, this section discusses alternatives for both short-term and long-term improvements to the City of Lanesboro's collection system and wastewater treatment infrastructure.

B. INFILTRATION AND INFLOW REDUCTION

According to the analysis in Section 3, the existing collection system exceeds MPCA threshold values of excessive infiltration and inflow by nearly 20 percent. This has potential implications on wastewater treatment, especially concerning excessive inflow during storm events that may hydraulically overload the system and result in the bypass of untreated wastewater directly to the Root River.

1. Infiltration Reduction

Options to eliminate groundwater infiltration into the sanitary collection system include both pipe replacement and rehabilitation. Conditions of sanitary services typically match that of the mainline collection pipe. As such, it is recommended that corrective actions to replace or rehabilitate the sanitary main also be extended to sewer services within the public right-of-way.

a) Pipe Rehabilitation

Rehabilitation of the existing sewer mains could be implemented through the use of cured-in-place pipe (CIPP). This construction method is executed by inserting a liner into the existing pipe which is inflated to match the existing pipe interior. This method can be used to line both mainline sewer as well as services.

The primary advantage of sewer lining is the ability to seal joints and cracks in existing pipe without the need to replace overlying paved surfaces. Although CIPP lining sanitary main is more cost effective than pipe replacement and surface restoration, the estimated cost of lining individual service lines far exceeds the respective cost for excavation and replacement. It is possible that segments of sanitary main with severe sags cannot be repaired through the use of CIPP lining. Also, repairs would be required within the main in areas where the existing pipe is deteriorated to a point where it is no longer structurally sound. These areas can be spot repaired with conventional excavation and replacement.

Sanitary manhole rehabilitation can be accomplished through the installation of internal liner systems. Although several liner systems are available, internal, poured concrete liners are typically the most effective and should be planned where conventional excavation and replacement of structures is less cost effective.

Prior to proceeding with a pipe lining project, additional information in the form of sewer televising should be completed to evaluate the overall conditions present.

b) Pipe Replacement

Another option to address infiltration into the existing main and services includes complete excavation and replacement. This method would include the removal of overlying surfaces, trench excavation, removal of the existing pipe, and installation of new gasketed-joint, PVC pipe. Sanitary service lines could also be replaced within the public right-of-way. Manhole structures can be replaced with new reinforced concrete structures with booted pipe connections.

A significant portion of the cost associated with full depth reconstruction is replacement of paved surfaces. Despite these costs, full depth reconstruction is still typically more cost effective in areas where several sanitary service lines are present and requiring replacement.

2. Inflow Reduction

In addition to groundwater infiltration into the system through pipe defects, another significant contributor of clear water is through the connection of foundation drains and sump pumps to the sanitary collection system.

a) Existing Sump Pump Ordinance

Section 51.062 of the City code strictly prohibits these types of connections. Existing structures subject to groundwater infiltration into basements must also have permanent systems in place for removal of water. The sewer ordinance allows inspections of new and existing building sewers. Properties found to be out of compliance with code requirements are given notice and are subject to the $100 monthly surcharge to the property owner's wastewater service bill until the sewer is brought into compliance.

b) Other Cross-Connections

Other sources of direct inflow may include cross-connections with storm sewer and other miscellaneous drain tile that are not found through residential and commercial inspections. These connections can be identified through sewer televising, smoke testing, and dye testing of the City-owned sanitary and storm sewer mains.

Individual property inspection programs can be completed to identify any illegal connections currently in place within the City. These programs can be completed city-wide or limited to suspect areas. Any properties found to be out of compliance are commonly given a period of time to remedy the issue. Once the repair is made, a second inspection of the home is commonly completed to verify that the improvements are in compliance with City code. Inspection programs are relatively low in cost and can be highly effective in eliminating inflow, if performed properly.

Prior to moving forward with sanitary replacement or rehabilitation, we recommend that non-PVC sanitary sewer throughout the City be televised. Once this inspection is complete, video can be reviewed to confirm the conditions of the mainline sewer. This information can also be used to prioritize sewer improvements into the future.

C. GENERAL TREATMENT ALTERNATIVES

There are several categories of alternatives that are given consideration when determining effective wastewater treatment improvements. For the City of Lanesboro, these general alternatives include:

1) Rehabilitation of the existing attached-growth treatment process as required until new WWTF on-line;
2) Construction of a new suspended growth activated sludge process;
3) Do nothing.

1. Rehabilitation of Existing Facility

Rehabilitation of the existing 80-year old treatment process is not a viable solution for the City of Lanesboro. Based on the evaluation presented in Section 4, most of the existing equipment is beyond its expected useful life and requires replacement in the next 3 to 5 years. The existing buildings and structures are original to the facility and are beyond their useful lives. There is also a high potential for the facility to receive nutrient limits for phosphorus and nitrogen removal over the next 5 to 10 years. The existing treatment process is not equipped to achieve nutrient removal. Therefore, a significant investment in rehabilitation would likely only get the City another 5 to 10 years of treatment before a new facility is needed due to limits.

On a short-term basis, the City may be required to replace old equipment over the next 3 years in order to maintain treatment performance while a new facility is constructed. This includes replacement of old pumping equipment, trickling filter components, and clarifier mechanisms. If these processes were to suddenly fail, they would need to be replaced on an emergency basis to avoid potential permit violations.

2. Construction of a New Treatment Facility

The other general alternative is to construct a new treatment facility that is specifically designed to meet the City's current and future treatment needs. Since the timing and potential for more stringent discharge limits is unknown, the new facility would be designed to accommodate phased construction for future projects that address phosphorus and total nitrogen removal.

As a sub-alternative, the City could also consider incorporating all current and future needs into a single construction project, which would include additional infrastructure needed to meet phosphorus and nitrogen limits. If this option is pursued, it is recommended that Lanesboro consider the costs and benefits of a regulatory certainty agreement, which would typically have the facility accept a phosphorus limit of 1 mg/L and a total nitrogen limit of 10 mg/L. Such an agreement would lock in those limits for a period of 20 years, preventing more stringent limits from being imposed. It may also allow the City to qualify for a Point Source Implementation Grant (PSIG), which could offset some cost of a facility upgrade. These benefits are offset by the need for additional capital improvements, increased treatment process complexity, and increased operational costs.

3. Do Nothing

Based on our discussions with City staff and the evaluation in Section 4 of this report, the "do nothing" alternative is not viable. The facility has unavoidable improvements that are required in the next 3 to 5 years, including replacement of clarifier mechanisms, trickling filter components, and pumping equipment. Therefore, this alternative is not considered further in this report as it is not feasible.

D. DISCUSSION OF ALTERNATIVE TREATMENT OPTIONS

If the City of Lanesboro elects to construct a new treatment facility, several different technologies may be considered for meeting current and future discharge requirements. The following paragraphs discuss an exhaustive list of these options. While many are not feasible, this section is included to provide an overview of all systems considered.

1. Non-Mechanical Treatment Facility

a) Aerated Lagoon System

An aerated lagoon system is designed to reduce the solids and biochemical oxygen demand of the wastewater through settling and decomposition by the bacteria living in the system. These systems can be designed as continuous discharge or controlled discharge. At a minimum, these systems consist of two or more aerated cells (of equal size) and one quiescent cell that provides 2 days of storage. Depending on the strength of influent wastewater, cell requirements may increase in number and size. Seasonal ice cover and sludge accumulation also factor into the sizing of aerated lagoon systems. Lagoon depth must be at least 5 five feet, but are typically in the 10-15 feet range.

There are several disadvantages to using a lagoon system to treat Lanesboro's wastewater. Lanesboro's existing treatment facility does not include any lagoons so all lagoon construction would be new construction. Significant flat land area would be required for a lagoon system, which is not readily available in the Lanesboro area.

Aerated lagoon systems are not reliable for ammonia removal in cold weather conditions due to the relatively long hydraulic residence time and reduced nitrification rates at water temperatures below 50 deg. F. This is particularly important to note if the City receives an ammonia or total nitrogen limit in upcoming permitting cycles. Aerated lagoon systems are not capable of significant total nitrogen removal or biological phosphorus removal. Based on the limitations described above, an aerated lagoon process is eliminated from further consideration in this report.

b) Constructed Wetlands

Constructed wetlands may be used to treat relatively low flow and low strength waste streams. Similar to the aerated lagoon option, constructed wetlands require significant land area with suitable soils. Additionally, constructed wetlands have consistently failed in northern climates due to freezing. For these reasons, constructed wetlands were eliminated from further consideration.

Finally, because of karst conditions in southeast Minnesota, wetlands and ponds are not feasible and will not be considered further.

2. Mechanical Treatment Facility

The City of Lanesboro's existing treatment facility is considered a "mechanical" treatment facility because it involves a combination of physical, biological, and chemical processes to achieve treatment objectives. Mechanical facilities may include a combination of the following treatment components: preliminary treatment, primary treatment, secondary treatment, tertiary treatment, disinfection, and biosolids handling and disposal. The general purpose and function of each of these components is described below:

- *Preliminary Treatment* – involves the removal of constituents that can clog or damage equipment and interfere with downstream processes. These constituents may include inorganic solids such as rags, paper, wood, and garbage, as well as oil and grease. General technologies utilized include screening and grit removal devices.
- *Primary Treatment* – involves the physical separation of suspended solids utilizing clarifier technology. This separation reduces solids not removed in preliminary processes, as well as removal of a portion of influent biochemical oxygen demand (BOD) that is associated with the organic solids removed in the primary treatment process.
- *Secondary Treatment* – involves the removal or reduction of contaminants that are not removed during primary treatment. This can be done through a combination of biological, physical, and chemical processes. Biological treatment involves the oxidation of pollutants such as organics and nitrogen through bacterial metabolism. Biological processes are often combined with physical processes such as clarification or membrane filtration to retain bacteria and remove suspended solids from the waste stream. Chemicals are commonly added to optimize the process or to help remove pollutants such as phosphorus. A wide variety of secondary treatment processes are utilized in the wastewater industry. Raw wastewater characteristics and flow rates dictate which processes are necessary.

- *Tertiary Treatment* – involves the use of advanced wastewater treatment technologies to further remove pollutants from wastewater. Tertiary treatment technologies include tertiary sand filtration, ion exchange, carbon adsorption, and membrane processes. Tertiary treatment is required for plants with very stringent total suspended solids, CBOD, TN and TP discharge limits. Tertiary treatment may also be required for removal of specific contaminants such as organic contaminants that are not removed in conventional biological secondary treatment or heavy metals.
- *Disinfection* – involves the destruction or inactivation of waterborne pathogens prior to discharging effluent to receiving waters for the purpose of minimizing public health threats. Disinfection can be done both chemically and physically. Chemical disinfection most commonly includes the use of chlorine-based products to destroy pathogens. Physical disinfection most commonly includes the use of ultraviolet irradiation (UV) to inactivate the pathogens' ability to replicate.
- *Biosolids Handling and Disposal* – involves the processing, storage, and disposal of biosolids generated at a wastewater treatment facility. Biosolids are derived from excess growth and subsequent disposal of bacteria and other microorganisms in the biological treatment process, as well as solids collected in the primary treatment process. Biosolids are collected and further stabilized through biological processes and stored/dewatered over the year to increase solids concentration. Depending on the degree of stabilization, biosolids are most commonly disposed through land application.

In most domestic wastewater treatment applications, biological secondary treatment is the key component in the process. Biological treatment generally utilizes either suspended growth or attached growth processes. In suspended growth systems, microorganisms responsible for the oxidation of pollutants are suspended in the wastewater through mixing and aeration. In attached growth systems similar to Lanesboro's current facility, the microorganisms become attached to a media where they are exposed to organic matter as wastewater flows by the media. There are also hybrid systems which utilize a combination of suspended growth and attached growth processes. Table 6.1 summarizes commonly used biological secondary treatment processes.

Table 6.1 – Mechanical Wastewater Treatment Processes

Type	List of Processes
Suspended Growth	- Extended Aeration Activated Sludge - Oxidation Ditch - Membrane Bioreactor (MBR)
Attached Growth	- Trickling Filter (*Existing*) - Rotating Biological Contactor (RBC)

Important criteria for selecting a treatment process include the following:

- Ability of process to meet effluent quality requirements;
- System reliability;
- Ability of process to maintain performance during hydraulic fluctuations;
- Capital costs;
- Operation and maintenance costs (O&M);
- System expandability to meet future capacity requirements;
- System adaptability to meet future effluent quality requirements.

The following paragraphs summarize many of the treatment processes listed in Table 6.1.

a) Extended Aeration Activated Sludge

Extended aeration activated sludge process utilizes an aeration system to provide dissolved oxygen for biological metabolism and mixing for suspended growth. Air is supplied from positive-displacement or centrifugal blowers and is dispersed in the aeration basins via a network of fine-pore diffusers that maximize oxygen transfer and provide mixing. In a typical activated sludge process, incoming wastewater undergoes screening and grit removal prior to aeration. From the aeration basins, wastewater is conveyed to the final clarifiers where solids and biomass are settled out and either recirculated back into the aeration basins or wasted to the biosolids handling system. Clarified effluent travels over the weirs and is conveyed to the disinfection system.

Extended aeration, which is a modification of conventional activated sludge treatment, eliminates the need for a primary clarifier and utilizes a larger aeration basin and longer solids retention. Extended aeration is known to produce high quality effluent and is a widely used, reliable technology. In addition, extended aeration systems are adaptable to achieve nutrient removal and produce a low level of sludge in comparison to the conventional activated sludge process. *For these reasons, extended aeration should be considered for the City of Lanesboro's wastewater system improvements.*

b) Oxidation Ditch

The oxidation ditch process is a variation of the activated sludge process. This process is used in nearby towns such as Rushford and Spring Valley. The oxidation ditch process typically includes course screening, grit removal, one or more close loop aerated channels for biological treatment, secondary clarification, and disinfection. The closed-loop configuration is often called a "racetrack type" reactor, as wastewater travels in a circle until it is released from the reactor and travels to the secondary clarifiers.

Long solids retention times (SRTs) associated with oxidation ditch system allow for a high degree of nitrification. An oxidation ditch system can be operated to achieve partial denitrification with the addition of an anoxic tank and proper recirculation, however TN removal can be difficult to control. Biological phosphorus removal is also possible with the addition of an anaerobic tank prior to the ditch. Key advantages include: low sludge production due to long solids retention times; adaptability to achieve nutrient removal; and common wall construction of racetrack tank design. Disadvantages include: potential freezing problems with surface aerators; relatively high maintenance requirements; larger land requirements (tanks need to be shallower since surface aeration is used); more difficult to control process compared to other activated sludge options; and the system is considered proprietary so limited equipment options are available. *Due to these reasons,* *the Oxidation Ditch process has been eliminated from consideration as it is similar to activated sludge and costs the same or more.*

c) Membrane Bioreactor

Membrane bioreactors (MBRs) utilize the extended aeration activated sludge treatment process. However, the major difference is that final clarifiers are replaced with micro- or ultrafiltration membranes for physical solids separation. The use of membranes for solids separation is advantageous in that system performance is not dependent on sludge settling characteristics, which can be problematic in conventional systems. Also, membranes remove virtually 100% of solids from the treated effluent and retain all biomass in the biological system. This allows the system to run at higher solids concentration and significantly longer SRTs without a reduction in performance – effectively reducing reactor size requirements and minimizing solids production.

Despite smaller land area requirements, membranes are expensive and need frequent replacement every 3 to 5 years. Capital costs are similar or slightly higher compared to conventional systems, but life-cycle costs are known to be higher due to membrane replacement. More importantly, operation and maintenance costs are much higher due to fouling control and chemical cleaning requirements. Fouling control can be difficult to manage since filterability is highly dependent on wastewater characteristics – especially temperature.

Although MBR systems are known to produce extremely high effluent quality, other activated sludge based systems can produce high effluent quality at a lower operating cost. MBR systems are most commonly used in low flow systems that have both space restrictions and require extremely high effluent quality. The City of Lanesboro's situation is fairly conventional and does not fall under any of these requirements; *therefore, an MBR treatment system has been eliminated from further consideration.*

3. Biosolids Handling and Disposal

a) Mechanical Treatment Facilities

Mechanical treatment facilities generate excess biosolids that must be removed from the system. Biosolids are derived from two primary sources: 1) excess biological growth wasted from the biological treatment process and 2) solids captured in primary treatment. Proper handling and disposal of biosolids is an important aspect of wastewater treatment. A method that is economical and acceptable to human health, the environment, and aesthetically must be selected.

The most practiced disposal method for rural communities like Lanesboro is land application, which the City currently practices. The City operators are certified in Type IV biosolids application and work with local farmers for sludge application in the fall and spring. As an alternative, the City could contract with a licensed applicator for sludge hauling and land application.

Biosolids storage can be a major cost and economic handling and storage must be considered. Increasing the solids content of the sludge is a cost effective way to help store and handle the solids. The City of Lanesboro's existing facility utilizes dual drying beds to help dewater the solids to concentrations between 40 to 50 percent. When properly designed, drying beds are an extremely effective and energy efficient method to dewater biosolids and should be considered for future improvements.

Drying beds are typically used in combination with aerobic or anaerobic digestion. An aerated digester is a covered tank with a coarse-bubble aeration system for mixing and odor reduction. The aerobic process provides a long retention time to allow endogenous respiration and decomposition of volatile organics, significantly reducing pathogens to produce Class B biosolids that can be used for agricultural applications. When used in combination with drying beds, the aerobic digester would be provided with 180 days of storage to account for cold weather months when the drying beds are not as effective. The digester would include piping and valves to decant supernatant from the tank back to the head of the treatment process – effectively concentrating the biosolids in the tank. Increasing solids concentration reduces storage volume and associated land disposal costs.

Anaerobic digestion could also be considered as an alternative to aerobic digestion. Anaerobic digestion is a process that biological breaks down organic material in the absence of oxygen. The resulting byproducts include biogas, which is a combination of methane and carbon dioxide, and stabilized biosolids that have significant reductions in volatile solids and pathogens. However, anaerobic digestion is a complex process that requires expensive gas draw-off equipment and heating elements. It is usually used in combination with primary clarification due to the need to breakdown dense, less biodegradable organics. If the extended aeration process is used, primary clarifiers and anaerobic digesters are generally not required, therefore, *anaerobic digestion is eliminated from consideration.*

b) Other Biosolids Technologies

An alternative to aerated digestion would be consideration of other technologies to produce Class A biosolids. These options include biosolids drying/incineration, lime pasteurization, and auto-thermal thermophilic aerobic digestion (ATAD). These options are often considered in metro areas that lack land availability. They also come with significant increases in capital and operating costs and, therefore, are not justifiable since the City has ample agricultural options for land disposal.

E. TREATMENT ALTERNATIVES CONSIDERED

A discussion of potential wastewater system improvements was conducted in Section 6D of this report. Based on these discussions and knowledge of Lanesboro's current and future treatment needs, the following alternatives have been identified and will be considered throughout the rest of this report:

- *Alternative No. 1* – Rehabilitate the Existing Facility (Not a feasible alternative)
- *Alternative No. 2* – Construct New Extended Aeration Activated Sludge Facility (without Nutrient Removal)
- *Alternative No. 3* – Construct New Extended Aeration Activated Sludge Facility (with Nutrient Removal)

It should be reiterated that the "do nothing" alternative is not a viable option considering the inevitable improvements that are required in the next 3 to 5 years, including replacement of clarifier mechanisms, influent screen, and trickling filter components. These improvements are included in efforts to rehabilitate the facility in Alternative No. 1.

1. Alternative No. 1 – Rehabilitation of Existing Facility

This alternative considers short-term rehabilitation efforts with the intention of prolonging the facility's service life another 5 years at best. The existing 80-year old facility is functioning and meets current permit limits, however, there are a number of imminent needs to ensure the facility maintains operation and avoids discharge violations through the next permitting cycle (5 year duration). This includes replacement of old pumping equipment, trickling filter components, and clarifier mechanisms. Beyond this 5-year timeframe, the reliability of the existing infrastructure is not feasible.

Ultimately, rehabilitation efforts are essentially a transitional investment to keep the existing facility running until a new facility is constructed in the next 5 years. Therefore, the investments made to rehabilitate the existing facility would be largely lost costs (i.e. irrecoverable). The existing components could not be integrated into a new facility due to space limitations at the existing facility and technological incompatibility. There may be a potential to recover some of the costs through equipment salvation. In light of these realizations, we would recommend the City to take a reactionary approach to rehabilitation efforts and only replace items as needed.

The following replacement items may be considered on an as-needed basis over the next 2 to 4 years:

- Replacement of existing mechanical bar screen;
- Replacement of HVAC equipment in influent pump station wet well;
- Replacement of existing Primary Clarifier mechanism;
- Replacement of existing trickling filter steel distribution arm and seal with aluminum materials;
- Replacement of existing Secondary Clarifier mechanism.
- Replace trickling filter media with new plastic media;
- Replace existing sludge transfer pump;
- Replace two (2) existing raw influent pumps;
- Replace existing screw lift pump;

The City has also discussed other general upgrades to the facility which are considered as more long-term improvements. We advise against these improvements as they are not ultimately cost effective pursuits, but include the following:

- Retrofit existing chlorine contact basin into a new UV disinfection system; remove chemical feed systems;
- Renovate existing biosolids storage tank into aerated storage; interior rehabilitation of tank; construct a new positive displacement blower enclosure for aeration;
- Rehabilitate the existing drying beds with new sand/gravel layers, underdrain piping, and installation of a shelter over the beds;
- Renovations to existing Operations Building, Primary Clarifier Building, and Trickling Filter enclosure. Replacement of existing obsolete electrical and controls system.

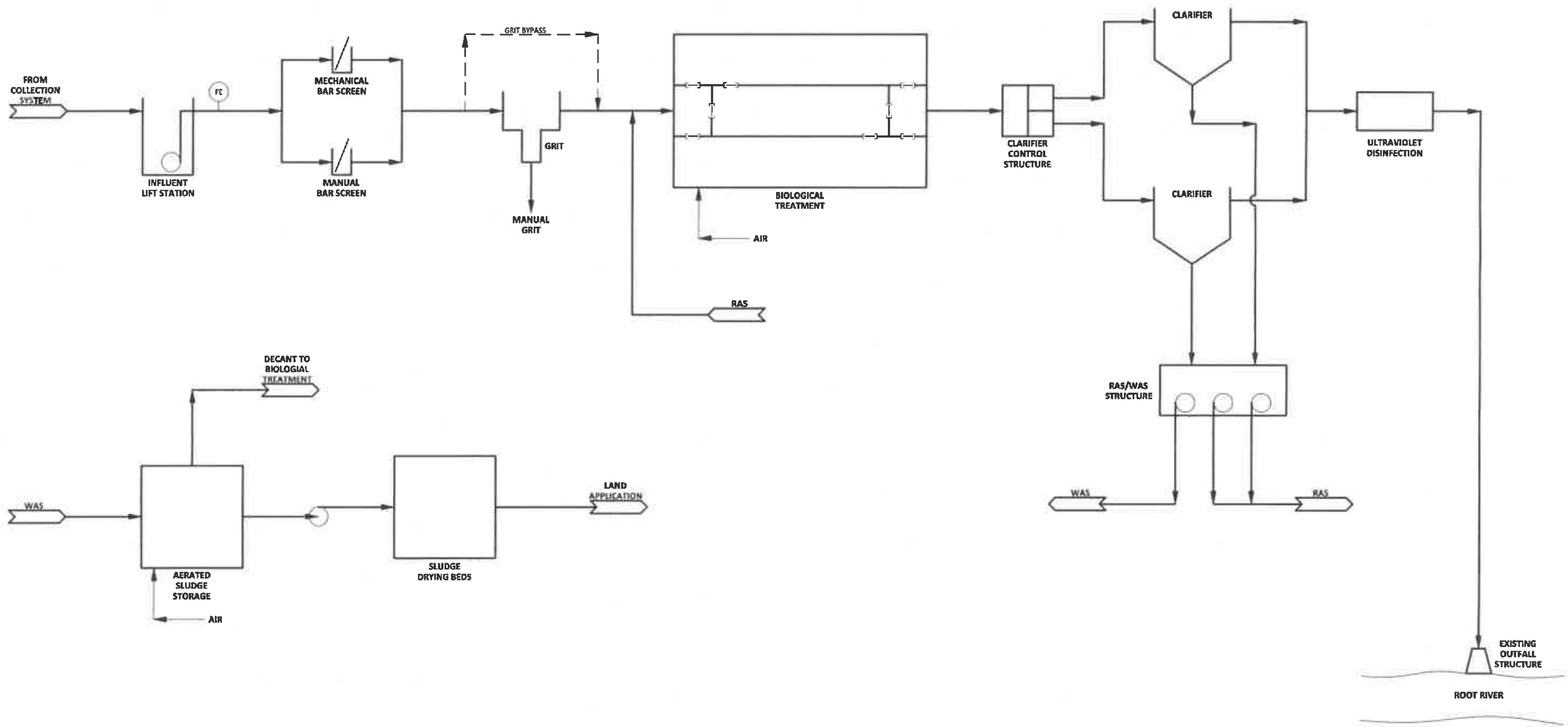
2. Alternative No. 2 – Construct New Extended Aeration Activated Sludge Facility (without Nutrient Removal)

This alternative involves the construction of a new extended aeration activated sludge treatment facility without infrastructure to achieve biological nutrient removal of phosphorus and nitrogen. Figure 6.1 illustrates a general process flow diagram for this alternative. This alternative does include provisions to add this infrastructure at a later date if nutrient limits are imposed in future permitting cycles. Such provisions include space for future anaerobic and anoxic tanks, space for future chemical feed equipment, and piping stub-outs for future connections. These provisions are relatively inexpensive and do not require significant upfront capital, but rather foresight in the planning and design process. As an option, the final clarifiers and biosolids storage facilities could also be upsized to provide future capacity for supplemental chemical phosphorus removal.

This alternative recognizes that the existing facility is well beyond its expected useful life and significant investment in rehabilitation efforts are limited by the high potential for nutrient limits in the next few permitting cycles. If this is the case, the investments made to rehabilitate the existing facility would be largely sunk costs. This is because the existing components could not be integrated into a new facility, which is due in part to space limitations at the existing site and technological incompatibility with most components.

A new extended aeration facility would generally consist of the following major treatment components:

- New influent lift station
    - 6-foot diameter precast wet-well structure;
    - Two (2) submersible pumps rated for 300 gpm (each) with guiderails and lifting accessories;
    - Precast valve vault structure
    - Discharge piping and valves
- New Pretreatment Structure
    - Channel-mounted mechanical fine screen, bypass channel with manual screen (rated for 300 gpm pumping capacity);
    - Grit removal channel with manual removal, bypass channel;
    - Parshall flume flow metering (3-inch throat);
    - Fiberglass enclosure over entire structure.



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LANESBORO, MINNESOTA

PRELIMINARY ENGINEERING REPORT

PROCESS FLOW DIAGRAM

ALTERNATIVE NO. 2 - EXTENDED AERATION ACTIVATED SLUDGE

FIGURE 6.1

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- New Aeration Basin Structure
    - Cast-in-place concrete aeration basin structure, 125,000 gallon total effective volume (approximately 32' x 32' x 16' SWD);
    - Two (2) integral cast-in-place concrete control structures at influent and effluent of tank;
    - Hydraulic gates to control operation of basin (series vs. parallel flow options);
    - Submerged fine-pore membrane diffusers and associated header piping and valves;
    - Floating dissolved oxygen (DO) sensor;
    - Three (3) positive displacement blowers (200 scfm @ 8 psi) located in new Control Building.
- New Final Clarifier Splitter Structure
    - Cast-in-place concrete splitter structure with aluminum stop gates.
- Final Clarifiers
    - Two (2) 20-foot diameter center-feed style final clarifiers (sized for future supplemental phosphorus removal through chemical addition);
    - Center-drive and walkway
    - Submerged sludge collection mechanisms (suction header);
    - Integral rotating skimming mechanism and scum beach;
    - Aluminum dome covers.
    - *As an alternative, the City may consider using rectangular clarifiers, which may have advantages in terms of saving space.*
- Scum Manhole
    - 6-foot diameter precast concrete wet-well structure;
    - One (1) submersible scum pump with guiderails;
    - Discharge piping and valves.
- RAS/WAS Structure
    - Cast-in-place concrete structure that receives final clarifier sludge and is equipped with return and waste pumping;
    - Two (2) submersible return activated sludge (RAS) pumps rated for 120 gpm capacity;
    - One (1) submersible waste activated sludge (WAS) pump rated for 50 gpm capacity;
    - Discharge valves and metering would be located in new Control Building.

- New Control / UV Building
  - UV Disinfection room with dual-bank UV system (in series);
  - Electrical room that houses the facility's main electrical distribution and switchgear;
  - Blower room;
  - Office/laboratory area;
  - Bathroom;
  - Meter room for RAS and WAS pumping;
  - Mechanical room;
- New Sludge Storage Structure
  - Dual-chamber 125,000 gallon below-grade cast-in-place concrete tank (includes future storage space for phosphorus-related sludge through supplemental chemical feed);
  - Two (2) submersible sludge transfer pumps;
  - One (1) designated blower located in new Control Building;
  - Course-bubble aeration diffusers, header piping, and valves;
  - Decant piping and telescoping valves for supernatant draw-off;
  - *As an alternative, the City may consider an above-grade storage tank, which has a similar price point.*
- New Sludge Drying Beds
  - Dual-drying beds with sand/gravel layers;
  - Properly sized underdrain system;
  - Fabric truss style shelter.
- Installation of new emergency generator.

This alternative would require the procurement of approximately one (1) acre of land adjacent to the existing facility site to the north. This property is currently privately owned, including a portion owned by the state.

3. Alternative No. 3 – Construct New Extended Aeration Activated Sludge Facility (with Nutrient Removal)

This alternative involves the construction of a new extended aeration activated sludge treatment facility, including infrastructure to achieve biological nutrient removal of phosphorus and nitrogen. This alternative recognizes that the existing facility is well beyond its expected useful life and significant investment in rehabilitation efforts are limited by the high potential for nutrient limits in the next few permitting cycles. In particular, this alternative is desirable to the extent it triggers grant funding through the Point Source Implementation Grant (PSIG) program. This program provides grants of up to 80 percent of the eligible project cost with a maximum of $7 million dollars. Qualification for PSIG funding will require the City to accept new nutrient limits under a regulatory certainty program. Such limits are negotiated on a case-by-case basis, but a phosphorus limit of 1 mg/L and total nitrogen limit of 10 mg/L would be expected, along with a guarantee of no new limits in the following 20 years.

Preliminary design of a new biological nutrient removal facility is based on the A^2/O process (anaerobic-anoxic-oxic), which is a version of the activated sludge process with additional tankage for anaerobic and anoxic biological processes. Figure 6.2 illustrates a basic diagram of this process. The process uses a sequence of anaerobic, anoxic, and aerobic basins to promote the growth of microorganisms that sequester phosphorus and oxidize ammonia into nitrogen gas through nitrification and denitrification processes. The process includes the internal recirculation of nitrate-rich mixed liquor from the aerobic basins to the anoxic basin, where the nitrate is denitrified into nitrogen gas – effectively removed from the system.

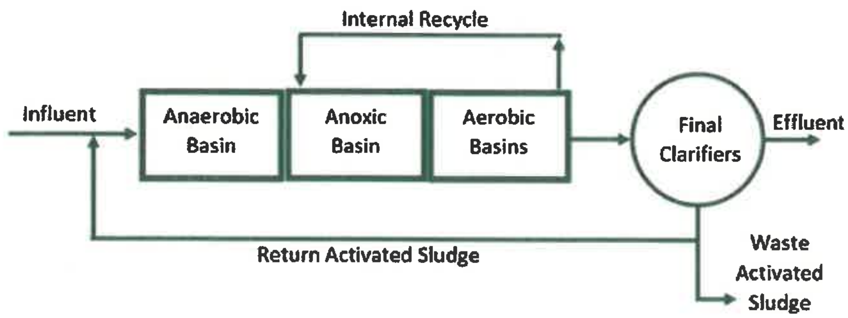


Figure 6.2 – A^2/O Process Diagram

This system would be designed similar to Alternative No. 2, including the following components:

- Anaerobic Basin
    - Integral to the overall biological treatment structure;
    - 12,000 gallon capacity (10' x 10' x 16' SWD)
    - One (1) submerged mixer (no aeration);
    - Receives return activated sludge from Final Clarifiers.
- Anoxic Basin
    - Integral to the overall biological treatment structure;
    - 12,000 gallon capacity (10' x 10' x 16' SWD)
    - One (1) submerged mixer (provisions for aeration);
    - Receives nitrate-rich internal recycle flow aerobic basin.
- Aerobic Basin
    - Integral to the overall biological treatment structure;
    - Submersible pump(s) installed inside aerobic basin for recycle back to Anoxic Basin;
    - Submersible fine-pore diffusers, header piping, and valves;
    - Hydraulic gates to control operation of basin (series vs. parallel flow options);
    - Floating dissolved oxygen (DO) sensor;
    - Three (3) positive displacement blowers (200 scfm @ 8 psi) located in new Control Building.

- Supplemental chemical feed
    - Option for supplemental chemical feed of metal salts (ferric chloride or aluminum sulfate) for chemical phosphorus removal

This option presents significant advantages and disadvantages – namely, the potential to capture grant dollars to help finance the improvements. Without volunteering for the regulatory certainty program, the facility would not be eligible through PSIG until it receives more stringent discharge limits in future permitting cycles. This potential financial advantage is offset by increased process complexity, additional energy demands from pumping and mixing, chemical feed costs, and the long-term burden of meeting effluent nutrient limits.

Similar to Alternative No. 2, this option would require the procurement of land. The additional infrastructure could still be constructed in the empty lot north of the existing facility. This property is largely privately owned, including a portion owned by the state.

F. RENEWABLE ENERGY AND "GREEN" CONSIDERATIONS

As a part of all alternatives, sustainable and "green" technologies are considered including premium efficiency motors and water saving ideas for internal wastewater use. While current and future permit limits dictate much of the required treatment, items such as anaerobic digestion and solar panels could be considered at a significant cost increase. Due to the very small organic loadings and prohibitively high capital costs, anaerobic digestion is not a feasible alternative. Additionally, solar panels at the small site are not recommended as the condensation from wastewater tanks could interfere with the panels. It also takes premium space away from the primary objective of treating wastewater at this site.

G. FINANCIAL CONSIDERATIONS

Published and unpublished data on costs for similar types of construction projects were used to prepare the opinion of costs presented herein. Annual inflation rates for this type of construction have ranged from approximately 2.5 to 5 percent in recent years. The cost opinions presented herein are intended for use as guidelines in the decision making process. The accuracy of these cost opinions should be considered within +/-20% of the actual project costs, therefore, cost ranges are provided to account for uncertainty. Once preparation of final drawings and specifications is underway, the cost opinions would be refined.

1. Capital Cost Opinion

The opinion of probable costs for the collection system and wastewater treatment alternatives are provided in the following Tables 6.2 to 6.5. Preliminary cost for engineering, construction oversight, administration, and legal are included.

a) Collection System Improvements

The purpose of collection system improvements is to eliminate excessive infiltration into the wastewater system. Sanitary sewer main and services within the public right-of-way can be replaced or lined or previously described in Section 6B. Cost estimates to implement these improvements for the estimated 28,500 lineal feet of non-PVC sanitary main are summarized in Table 6.2 below. It should be noted that the estimates include sanitary pipe and manhole replacement, and 50 percent of the full-depth reconstruction costs to reestablish street surfaces. Cost do not include water-main replacement or other utility work that is also recommended to be completed during this time.

Table 6.2 – Opinion of Capital Cost - Collection System Improvements	
Item	**Sanitary Sewer Replacement & Rehabilitation(1)**
Estimated Construction Subtotal	$4,700,000
Contingency (20%)	$1,000,000
Estimated Construction	**$5,700,000**
Engineering, Admin., Legal	$1,400,000
Project Total	**$7,100,000**

(1) Costs only include sanitary pipe and manhole replacement, and 50 percent of the full-depth reconstruction costs to reestablish street surfaces. Cost do not include water-main replacement and other utility work.

Due to the high cost of CIPP lining sanitary services, it is anticipated that complete replacement of existing sewer pipe will be a more cost effective means of reducing infiltration volumes into the collection system. CIPP may be applicable to some pipe-segments with a relatively low number of service connections or to main lines located within busier roads.

The above noted improvement options are intended to reduce the total volume of groundwater infiltrating into the collection system. Although currently unknown cross-connections between storm sewers and sanitary sewer may be revealed and corrected during design and later construction, another significant contributor of inflow into the system is private cross-connections of sump pumps and foundation drains into the sanitary sewer. Section 51.062 of the City code strictly prohibits these types of connections. We recommend the City revisit this issue and, if necessary, perform further investigation and enforcement of this ordinance.

b) Wastewater Treatment Improvements

Rehabilitation of the existing treatment facility in Alternative No. 1 provides the lowest upfront capital costs, with expected costs ranging from $1.75 to $2.50 million to address all known issues. These expenses should only be considered to help ensure the existing plant is operable over the next 5 to 10 years. There is lost value in much of these expenditures since they would not be incorporated into a new facility built in the next 10 years.

Alternatives No. 2 and 3 consider building a new treatment facility that would meet current and future discharge limits, thus, upfront capital costs are much higher. Alternatives No. 2 and 3 include similar costs, although Alternative No. 3 include additional infrastructure required for biological nutrient removal, including supplemental chemical feed for phosphorus removal. The expected cost difference between these alternatives is expected to range from $660,000 to $1,000,000.

Table 6.3 – Opinion of Capital Cost - Alternative No. 1 - Rehabilitation of Existing Facility		
Item	**Cost[1]**	
Imminent Needs (3-5 years) As Needed		
Mobilization, Bonds, Insurance	$	30,000
Rebuild Existing Mechanical Bar Screen & Controls	$	100,000
HVAC Equipment in Wet Well	$	10,000
Replace Primary Clarifier Mechanism	$	70,000
Rebuild Trickling Filter Distribution Arm & Seal	$	100,000
Replace Secondary Clarifier Mechanism	$	70,000
Replace Trickling Filter Media	$	100,000
Replace Existing Sludge Transfer Pump	$	30,000
Replace Existing Screw Lift Pump	$	25,000
Replace Two (2) Existing Raw Influent Pumps	$	60,000
Bypass Pumping & Coordination	$	20,000
Electrical Work	$	20,000
Subtotal	**$**	**635,000**
Other Considerations (5 years) Not Recommended		
Mobilization, Bonds, Insurance	$	30,000
Conversion of Chlorine Basin to UV Disinfection	$	180,000
Renovate Existing Biosolids Tank & Drying Beds	$	250,000
Rehabilitations to Existing Structures	$	100,000
Renovations to Existing Buildings	$	100,000
New Electrical & Control Equipment	$	150,000
Subtotal	**$**	**780,000**
Contingency (20%)	$	280,000
Construction Subtotal	**$**	**1,695,000**
Legal, Engineering, and Administration (20%)	$	340,000
TOTAL	**$**	**2,035,000**
Expected Range	**1.75 to 2.5 Million**	

(1) Not a feasible alternative. Only replace items as needed until new WWTF is constructed.

Table 6.4 – Opinion of Capital Cost - Alternative No. 2 - Construction of New Extended Aeration Facility (Without Nutrient Removal)		
Item	**Cost**	
Mobilization, Bonds, Insurance	$	150,000
Influent Lift Station	$	85,000
Pretreatment Structure	$	235,000
Biological Treatment	$	405,000
Splitter Structure & Gates	$	40,000
Final Clarifiers & Domes	$	360,000
Scum Manhole & Pumping	$	30,000
RAS/WAS Structure & Pumping	$	130,000
Control / UV Building & Equipment	$	665,000
Sludge Storage Tank & Equipment	$	265,000
New Sludge Drying Beds	$	140,000
Process Piping and Valves	$	450,000
Site Work, Fill Material, and Paving	$	300,000
Demolition of Existing Facility	$	100,000
Process and Building Coating Systems	$	100,000
Plumbing and HVAC Systems	$	160,000
Electrical, Instrumentation, & Controls	$	800,000
Emergency Power Generation	$	60,000
Subtotal	**$**	**4,475,000**
Contingency (20%)	$	900,000
Construction Subtotal	**$**	**5,375,000**
Legal, Engineering, and Administration (20%)	$	1,080,000
TOTAL	**$**	**6,455,000**
Expected Range	**5.25 to 7.75 Million**	

Table 6.5 – Opinion of Capital Cost - Alternative No. 3 - Construction of New Extended Aeration Facility (With Nutrient Removal)		
Item	**Cost**	
Alternative No. 2 Subtotal	$	4,475,000
Biological Treatment Additions	$	
Anaerobic Basin	$	
Concrete, Earthwork, and Materials	$	50,000
Submersible Mixing	$	20,000
Anoxic Basin	$	
Concrete, Earthwork, and Materials	$	50,000
Submersible Mixing	$	20,000
Anoxic Return Pumping & Piping	$	25,000
Supplemental Chemical Feed (P Removal)	$	50,000
Additional Site Work	$	20,000
Additional Site Piping and Valves	$	100,000
Additional Electrical, Instrumentation, & Controls	$	125,000
Subtotal	**$**	**4,935,000**
Contingency (20%)	$	990,000
Construction Subtotal	**$**	**5,925,000**
Legal, Engineering, and Administration (20%)	$	1,190,000
TOTAL	**$**	**7,115,000**
Expected Range	**6 to 8.5 Million**	

2. Operation, Maintenance, and Replacement Costs (OM&R)

Operation and maintenance costs can have a significant effect on the overall cost of wastewater treatment. Major components of the O&M costs include employee salaries and benefits, administration, chemicals, utilities, and other non-capital related expenditures. Table 6.6 summarizes expected O&M costs for the wastewater treatment alternatives.

Compared to the existing O&M costs, Alternative No. 1 is expected to reduce costs for repairs/services and chemical feed. However, utilities costs are expected to increase with the use of UV versus chlorine disinfection. Alternative No. 1 also includes an additional budget item for short-lived asset reserves, which is discusses more in subsequent paragraphs.

Alternatives No. 2 and 3 are expected to see higher utility costs for the new aeration equipment and UV disinfection modules, which accounts for much of the overall increases in O&M costs. Alternative No. 3 has the highest overall O&M cost, which includes budgeted items for additional testing, biosolids handling, and the highest short-lived asset reserves. Increased costs for biosolids handling accounts for additional sludge production as a result of supplemental chemical phosphorus removal.

Short-lived assets are items that typically require replacement within a 15 year time frame. We recommend having an annual budget in place to help finance these items. Short-lived assets may include pumps, chemical feed equipment, mixers, and other equipment that may require replacement within the design life of the system. A breakdown of estimated short-lived asset reserve costs for each alternative is presented in Table 6.7. The total budgeted values for each alternative are included in Table 6.6.

Table 6.6. – Estimated Operation and Maintenance Costs
City of Lanesboro, Minnesota

Item	3-Year Average	Alternative 1 – Rehabilitation[(1)]	Alternative 2 - Extended Aeration	Alternative 3 - Extended Aeration + BNR
Worker Compensation & Benefits	$50,837	$50,000	$55,000	$55,000
Utilities	$9,974	$15,000	$50,000	$50,000
Maintenance, Repairs, & Services	$19,443	$15,000	$15,000	$15,000
Chemical	$15,617	$5,000	$5,000	$12,500
Supplies and Equipment	$5,570	$5,500	$5,500	$5,500
Insurance	$1,415	$1,500	$2,500	$2,500
Permit Fees and Training	$3,533	$3,500	$3,500	$3,500
Miscellaneous	$6,687	$6,500	$7,500	$7,500
Testing (+/-)		No Change	No Change	$2,500
Biosolids Handling (+/-)	--	No Change	No Change	$5,000
Short-Lived Asset Reserve	--	$17,000	$20,000	$28,000
Subtotal	**$113,076**	**$119,000**	**$164,000**	**$187,000**

(1) Alternative No. 1 is not a feasible option. Maintenance only until new WWTF is constructed.

Table 6.7 – Short-Lived Asset Reserves City of Lanesboro, Minnesota							
Item	**Useful Life**	**Alternative No. 1 (1)**		**Alternative No. 2**		**Alternative No. 3**	
		Total	**Annual**	**Total**	**Annual**	**Total**	**Annual**
Raw Lift Station Pumps	15	$60,000	$4,000	$35,000	$2,333	$35,000	$2,333
Biological Treatment							
Air Diffusers	10	--		$15,000	$1,500	$15,000	$1,500
Submersible Pumps	15	--		--		$20,000	$1,333
Submersible Mixers	15	--		--		$40,000	$2,667
Screw Lift Pump	15	$25,000	$1,667	--		--	
Biosolids Processing							
RAS Pumps	15	--		$40,000	$2,667	$40,000	$2,667
WAS Pump	15	--		$20,000	$1,333	$20,000	$1,333
Scum Pumping	15	--		$10,000	$667	$10,000	$667
Biosolids Pump(s)	15	$30,000	$2,000	$20,000	$1,333	$20,000	$1,333
Chemical Feed System							
Ferric Chloride	15	--		--		$50,000	$3,333
UV Disinfection	15	$100,000	$6,667	$100,000	$6,667	$100,000	$6,667
Miscellaneous							
Samplers	15	$20,000	$1,333	$20,000	$1,333	$20,000	$1,333
Misc. Piping & Valves	15	$10,000	$667	$20,000	$1,333	$20,000	$1,333
HVAC	10	$5,000	$500	$10,000	$1,000	$10,000	$1,000
Subtotal			*$17,000*		*$20,000*		*$28,000*

(1) Alternative No. 1 is not a feasible option. Maintenance only until new WWTF is constructed.

3. Annual Project Costs

Determination of annual project costs is a useful measure to compare multiple alternatives on a financial basis. Annual project cost is the sum of the anticipated OM&R cost and the annualized capital costs. Annualized capital costs represent the yearly sum of money needed to finance a capital expenditure over a specified period and interest rate (i.e. capital recovery). Table 6.8 summarizes annual project cost for each alternative.

Table 6.8 – Estimated Total Annual Costs City of Lanesboro, Minnesota			
Item	**Alternative 1 – Rehabilitation(1)**	**Alternative 2 - Extended Aeration**	**Alternative 3 - Extended Aeration + BNR**
Total Project Capital Costs			
Collection System Improvements	$7,100,000	$7,100,000	$7,100,000
Wastewater Treatment Improvements	$2,035,000	$6,455,000	$7,115,000
Total Project Capital Costs	$9,135,000	$13,555,000	$14,215,000
Annualized Project Costs			
Collection System Improvements	$477,232	$477,232	$477,232
Wastewater Treatment Improvements	$136,784	$433,877	$478,240
Total Annualized Cost	$614,015	$911,109	$955,471
Annual OM&R Costs	$119,000	$164,000	$187,000
Annual Project Cost	$733,015	$1,075,109	$1,142,471

(1) Assumes 20-year loan at 3.0% annual interest rate

(2) Alternative No. 1 is not a feasible option. Replace items only as needed until new WWTF is constructed.

4. Life-Cycle Cost Analysis

Life cycle cost analysis (LCCA) is useful for assessing the long-term cost effectiveness of a project. Life cycle costs of each alternative were determined by performing a net present worth cost analysis over a 20-year period. A summary of this analysis is presented in Table 6.9 below. A detailed analysis for each alternative is located in Appendix G. Present worth costs are defined by the following equation:

Present Worth Costs = Total Capital Costs
+ Present Worth of Future Replacement Costs
+ Present Worth of Annual O&M Costs
Present Worth of Future Salvage Value

Salvage costs are determined using linear depreciation of all project-related infrastructure that is not considered a sunk (i.e. irrecoverable) cost after it is installed. Alternative No. 1 is expected to have the lowest life-cycle costs, under the assumption that rehabilitation efforts provide another 5 years of useful life. If the City receives more stringent permit limits in the next few permitting cycles (5-10 years), Alternative No. 2 would have the lowest life cycle costs because the rehabilitation efforts would not utilize their full value. Although the construction of a new facility is inevitable, the primary benefit of maintaining of the existing facility is savings in O&M costs relative to a new facility that requires more energy-intensive treatment processes.

Table 6.8 – 20-Year Present Worth Analysis City of Lanesboro, Minnesota			
Item	**Alternative No. 1[(1)]**	**Alternative No. 2**	**Alternative No. 3**
Total Capital Costs	$2,065,000	$6,455,000	$7,115,000.00
Replacement Costs	$6,900,000	$890,000	$1,005,000
Salvage Value	($3,405,000)	($2,657,333)	($2,944,833)
O&M Costs	$2,529,000	$2,440,000	$2,782,000
20-year Life Cycle Costs	**$8,089,000**	**$7,128,000**	**$7,957,000**

(1) Alternative No. 1 is not a feasible option. Replace items only as needed until new WWTF is constructed.

5. Impact to User Costs

Based on the projected capital and OM&R costs, Table 6.10 summarizes the projected user cost for each alternative. User costs were developed using the concept of the equivalent dwelling unit (EDU). Residential EDUs are equivalent to the number of household connections in the wastewater system. Commercial EDUs are calculated based on the ratio of residential and commercial water usage. This was done using historical billing information between 2015 and 2017. The City of Lanesboro charges identical rates to residential and commercial users, therefore billing information is directly proportional to actual water usage and can be used to calculate EDUs.

EDU Calculation:

Residential	
Number of EDUs/Connections	352
3-year Average Usage Revenue	$43,391
Commercial	
Calculated EDUs	153
3-year Average Usage Revenue	$18,840
Ratio of Res./Comm. Revenue	0.434
Total EDUs	**505**

Table 6.10 - Estimated User Costs City of Lanesboro, Minnesota				
Item	**Existing**	**Alternative 1 – Rehabilitation[4]**	**Alternative 2 - Extended Aeration**	**Alternative 3 - Extended Aeration + BNR**
Annual Costs				
Collection System Improvements	--	$477,232	$477,232	$477,232
Wastewater Treatment Improvements	--	$136,784	$433,877	$478,240
Annual OM&R	$113,076	$119,000	$164,000	$187,000
Existing Debt Service (3-year average)	$42,414	$42,414	$42,414	$42,414
Total Annual Costs	$155,490	$775,429	$1,117,523	$1,184,885
Additional Future Annual Costs[5]	--	$478,877	--	--
Residential EDU[1]	352	352	352	352
Commercial EDU[2]	153	153	153	153
Industrial EDU	0	0	0	0
Total EDUs	505	505	505	505
Monthly Cost per EDU	$25.66	$206.98	$184.41	$195.53
Calculated Affordability Threshold[3]				
2016 MHI = $50,250	$62.81	$62.81	$62.81	$62.81
2010 MHI = $31,923	$39.90	$39.90	$39.90	$39.90

(1) Residential EDUs equivalent to number of households per 2016 American Community Survey

(2) Commercial EDUs calculated based on historical sewer usage billing (2015-2017) in proportion to residential billing. Residential and commercial usage rates are identical.

(3) Based on 1.5% of median household income per American Community Survey (2010 and 2016)

(4) Alternative No. 1 is not a feasible option.

(5) Additional capital expenditures required 5 years after rehabilitation

H. SUMMARY OF ADVANTAGES & DISADVANTAGES

1. Alternative No. 1 – Rehabilitate Existing Facility

a) Advantages

(1) None – System needs replacement.

b) Disadvantages

(1) Not a long-term solution. Should only be considered to help ensure the existing facility is operable over the next 5 years until new WWTF is online.

(2) Does not address the fundamental problem of the facility's overall age and associated uncertainty with future issues that are currently unknown. This could potentially lead to acute failure of the treatment system if a process were to suddenly fail.

(3) Much of the investment into rehabilitation efforts would be lost costs not recoverable by the City. Creates higher life cycle costs compared to Alternative No. 2 and 3.

(4) Does not improve the facility's discharge quality.

2. **Alternative No. 2 – Construct New Extended Aeration Facility without Nutrient Removal**

   a) Advantages

      (1) Lowest overall life-cycle costs.

      (2) Provides the necessary infrastructure for another 50 to 60 years of treatment, with upgrades as needed.

      (3) Extended aeration activated sludge process is a robust, flexible treatment technology that would meet all of the City's current treatment needs, while providing expandability to meet future needs.

      (4) Provides high level of operator control.

      (5) Provides provisions to expand the facility as needed in response to future treatment needs, if required.

      (6) Less expensive treatment alternative compared to Alternative No. 3, which includes additional infrastructure for biological nutrient removal.

      (7) The incremental costs to upgrade to biological nutrient removal in the future may be eligible for PSIG grant money without a regulatory certainty agreement.

   b) Disadvantages

      (1) Increased capital costs compared to rehabilitation in Alternative No. 1.

      (2) Increased OM&R costs relative to Alternative No. 1, largely due to increased energy requirements.

3. **Alternative No. 3 – Construct New Extended Aeration Facility with Nutrient Removal**

   a) Advantages

      (1) Provides the necessary infrastructure for another 50 to 60 years of treatment, with upgrades as needed.

      (2) Meets all current and future treatment needs, including infrastructure for biological nutrient removal of phosphorus and nitrogen.

      (3) Provides high level of operational control and flexibility.

      (4) Potential to receive PSIG grant money to cover incremental costs to achieve biological nutrient removal.

   b) Disadvantages

      (1) Highest upfront capital costs of all alternatives

      (2) Highest OM&R costs of all alternatives

      (3) Highest life-cycle costs of all alternatives

      (4) Qualification for PSIG funding will require the City to accept new nutrient limits under a regulatory certainty program. Such limits are negotiated on a case-by-case basis, but a phosphorus limit of 1 mg/L and total nitrogen limit of 10 mg/L would be expected.

7. RECOMMENDATIONS AND IMPLEMENTATION

A. GENERAL

Previous sections of this report evaluated three (3) alternatives for wastewater system improvements for the City of Lanesboro, including proposed improvements to the City's collection system in order to abate excessive infiltration and inflow. This section will review these alternatives and provide a recommendation for wastewater system improvements based on both quantitative and qualitative factors, including financial considerations, reliability, expandability, and operation and maintenance considerations. Financing options and a proposed implementation schedule are also discussed.

B. DECISION MATRIX

Table 7.1 presents a decision matrix for the three (3) wastewater system improvements alternatives discussed in this report, including costs for proposed City-wide collection system improvements. Alternatives No. 2 and 3 provide the highest ratings in terms of meeting current and future treatment needs.

Table 7.1 – Decision Matrix
City of Lanesboro, Minnesota

Item	Alternative 1 – Rehabilitation[(1)]	Alternative 2 - Extended Aeration	Alternative 3 - Extended Aeration + BNR
Overall Ability to meet Improvements Needs	Poor	Excellent	Excellent
Expandability Potential	Very Poor	Excellent	Good
Ability to Current Discharge Limits	Fair	Excellent	Excellent
Ability to meet Future Discharge Limits	Very Poor	Excellent	Excellent
Land Requirement	None	1 acre	1 acre
Estimated Capital Costs			
Wastewater Treatment Improvements	$2,035,000	$6,455,000	$7,115,000
Collection System Improvements	$7,100,000	$7,100,000	$7,100,000
Future Replacement Costs (present worth)	$6,455,000	--	--
Total Capital Costs	$15,590,000	$13,555,000	$14,215,000
Estimated OM&R Costs	$119,000	$164,000	$187,000
Estimated Total Annual Project Costs	$1,254,306	$1,075,109	$1,142,471
Estimated Life-Cycle Costs	$8,089,000	$7,128,000	$7,957,000
Estimated User Costs (per EDU)	$206.98	$184.41	$195.53

(1) Alternative No. 1 is not feasible. 5-year alternative to maintain existing facility only.

C. RECOMMENDED ALTERNATIVE

1. Recommended Alternative

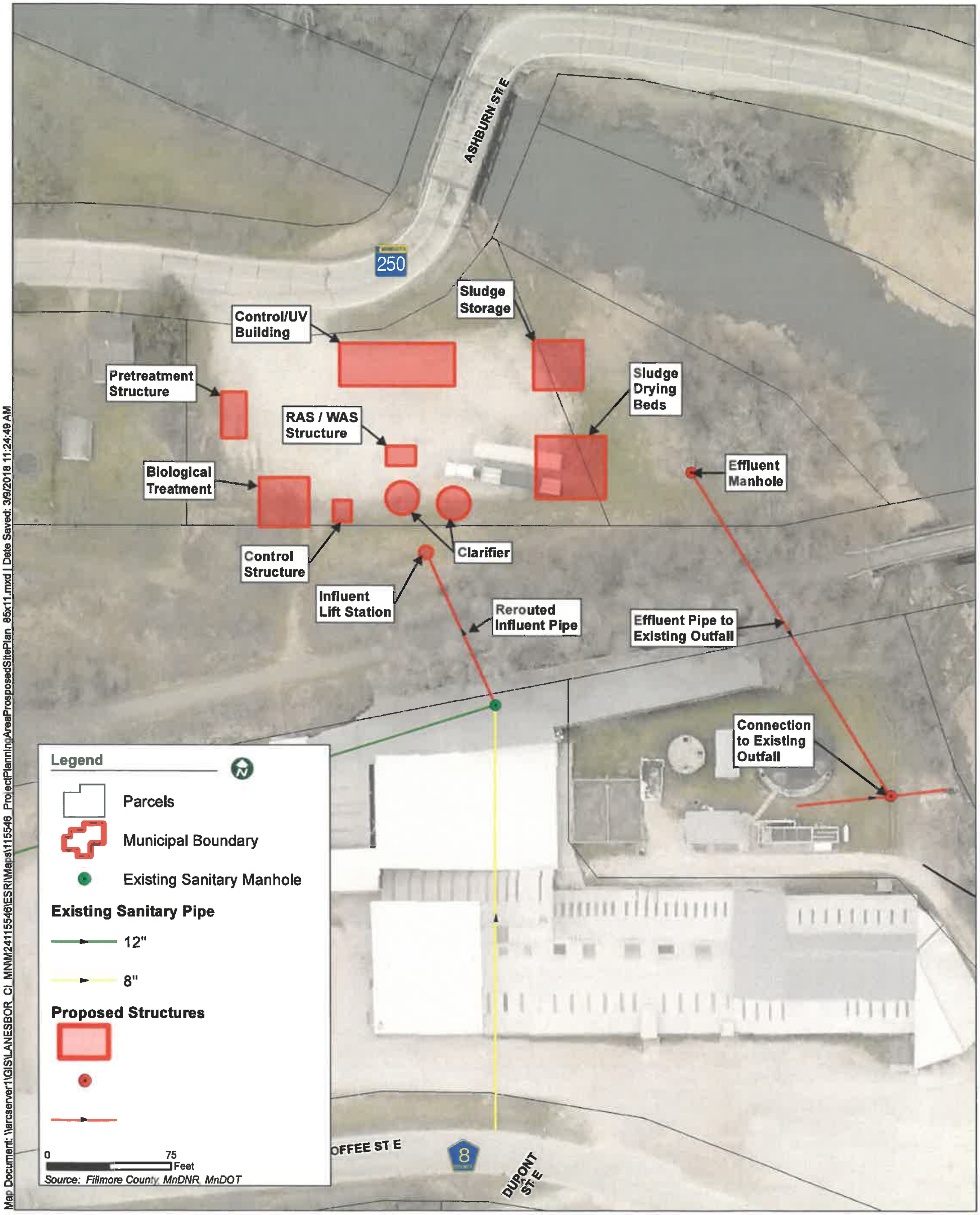
Based on the specific needs of the City of Lanesboro and the preliminary cost analysis, the recommended alternative for wastewater treatment improvements is Alternative No. 2 – Construction of a New Extended Aeration Activated Sludge Facility (without Nutrient

Removal). We also recommend implementing a capital improvements plan to replace the aging sanitary collection system infrastructure.

Key highlights and advantages of the recommended alternative include the following:

- Provides the City of Lanesboro another 50 to 60 years of wastewater treatment needs.
- Extended aeration activated sludge is a widely-used and reliable treatment technology that would meet all current treatment needs, while providing flexibility to expand the facility as needed in the future to meet nutrient limits.
- Due to uncertainty with future nutrient limits, this alternative provides a phased, reactionary approach that saves cost upfront while not volunteering for nutrient limits that cannot be reversed. This also does not close the door on future grant money available to cover the incremental costs to achieve nutrient removal.
- Provides the operators with greater control of treatment performance compared to the existing system.
- Provides much needed upgrades to the biosolids processing system.
- UV disinfection eliminates chemical costs, potential hazards associated with chlorine gas storage, and discharge limits for total residual chlorine.

A preliminary site plan of the proposed improvements is presented in Figure 7.1. The proposed improvements would fit in the adjacent property north of the existing site. Much of this open property is privately owned, while a portion along the Root River is owned by the state. This area is currently below the 100-year flood elevation and would need to be raised approximately 3 to 4 feet to accommodate the proposed improvements. The new facility would be constructed while the existing facility is in full operation. The existing outfall SD001 would be reused. Sanitary tie-ins of influent and effluent piping would be completed prior to startup of the new facility. During startup, the new and existing facilities would operate concurrently for approximately one to two months until the new facility is ready to accept full flow.



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2. **Cost Summary**

Table 7.2 provides a cost summary of the recommended Alternative No. 2.

Table 7.2 – Cost Estimate Summary of Alternative No. 2 City of Lanesboro, Minnesota	
Item	**Cost**
Capital Costs	
Wastewater Treatment Improvements	$6,455,000
Collection System Improvements	$7,100,000
Total Project Capital Cost	**$13,555,000**
Annual Costs	
Wastewater Treatment Improvements	$433,877
Collection System Improvements	$477,232
Projected O&M Cost	$164,000
Total Annual Project Costs	**$1,075,109**
Estimated User Costs (per EDU)	$184.41
Calculated Affordability Threshold(1)	
2016 ACS (MHI = $50,250)	$62.81
2010 ACS (MHI = $31,923)	$39.90

(1) Based on 1.5% MHI per American Community Survey (2010 & 2016)

D. FINANCING OPTIONS

There are several funding options the City of Lanesboro can explore to help finance the proposed improvements:

1. **Bonding**

The City could sell general obligation, local improvement, or revenue bonds in order to raise the capital costs to finance the treatment facility and collection system improvements. The proceeds of the bonds would need to be repaid, either through property taxes, assessments, or user charges to the system.

2. **Assessment**

A portion of the capital costs of the project can be assessed to local property owners under Minnesota Statute 429. Using this method, a one-time assessment could be levied and repaid over a period of 10 to 20 years. This cost could help offset some monthly increases in user fees and permit use of general obligation bonding.

3. **Rural Development (RD) Loan**

The United State Department of Agriculture (USDA) Office of Rural Development (RD) has a water and waste disposal program that provides low-interest loans and grant money for eligible communities under 10,000 population. In order to be considered for Rural Development financing, a Preliminary Engineering Report (PER) must be completed, which provides specific project and financial information for RD to consider. This is the intention of this report.

Rural Development uses an Equivalent Dwelling Unit (EDU) calculation for assisting in determining the amount and type of funding for which a community is eligible. Proposed project costs and preliminary EDU calculations indicate a high likelihood that the proposed project would be eligible for both loan and grant financing. The projected costs are expected to exceed the City's affordability threshold of $62.81 per EDU, which is calculated as 1.5% of Lanesboro's median household income (MHI) of $50,250 (per 2016 American Community Survey). The City would potentially be grant eligible for portions of the project that exceed this affordability threshold. Low-interest loans could potentially be used to pay for portions of the project below this threshold. Repayment of loans could be through an increase in local property tax rates, user fees, or assessments.

Rural Development loan financing is a 40-year term. Interest rates typically vary between 2.0 to 3.5 percent and are based on the City's median household income.

4. **State Revolving Fund Loan (through PFA)**

The Clean Water Revolving Fund (CWRF) loan program was created under the State Revolving Fund (SRF) provisions in the Federal Clean Water Act to provide financial assistance for water pollution control projects. Minnesota's revolving loan program provides loans to municipalities for planning, design and construction of wastewater treatment projects. The loans are typically for a 20-year period at an interest rate of two to four percent. The loan monies are administered through the Public Facilities Authority. To be eligible for PFA funding, the City must submit a Facilities Plan for review and approval by the Minnesota Pollution Control Agency.

Revenue for loan repayment is typically generated by user rates, availability charges or assessment. In recent years, interest rates have been below two percent, and this has proven to be an excellent funding source for this type of project.

5. **Small Cities Development Program**

The Small Cities Development Program provides federal grants from the US Department of Housing and Urban Development (HUD) to local units of the government on a competitive basis for a variety of community development projects. Eligible applicants include cities and townships with populations under 50,000 and counties with populations under 200,000.

The proposed project must meet one of the three (3) national objectives:

1. Benefit to low and moderately low-income persons;
2. Elimination of slum and blight conditions; or
3. Elimination of an urgent threat to public health or safety.

In addition, the proposed activities must be eligible for funding, project needs must be documented, and the general public must be involved in the application preparation.

Under this program, Small Cities Development Public Facility grants are available for wastewater treatment projects, including collection systems and treatment plants; fresh water projects, including wells, water towers, and distribution systems; storm sewer projects; flood control projects; and occasionally street projects. The maximum grant award for Public Facility project is $600,000.

6. **Wastewater Infrastructure Funding (WIF) Program**

Supplemental assistance to municipalities is currently available through the wastewater infrastructure (WIF) program. The Public Facilities Authority (PFA) administers the WIF program to those communities that are applying for funding under the Clean Water

Revolving Fund loan program or the United States Department of Agriculture Rural Economic and Community Development's (USDA/RECD) Water and Waste Disposal Loans and Grants Program.

Assistance is in the form of zero percent loans, which may be forgiven upon receipt of the notice from MPCA that the project operational performance standards have been met.

This program is income based. Since the proposed project costs would exceed the City's affordability threshold (calculated as 1.5% of MHI, or $62.81 per month for the average household), the project may be eligible for this financing source.

7. **Economic Development Administration**

The Economic Development Administration (EDA) has a grant program, which is used to help communities develop the infrastructure required to attract or maintain businesses or industries. Grant sizes vary depending upon the community's need and the impact the project would have on the community. If the City of Lanesboro expects to get an industry that provides jobs to its residents and has wastewater treatment need, the City may be eligible for an EDA Grant, or by leveraging existing industries it could also be eligible. Based on our discussion with City staff, Lanesboro is not expected any significant commercial or industrial growth over the 20-year planning period, therefore the City would not be eligible for this financing option.

8. **Point Source Implementation Grant (PSIG)**

The Point Source Implementation Grant (PSIG) is a grant program to assist and encourage communities to make infrastructure improvements in order to comply with new stringent NPDES permit limits, such as TMDL wasteload requirements, phosphorus reduction requirements, and water quality based effluent limits. The program is funded through the Clean Water Legacy Program and is competitive based on scoring from the MPCA under the same criteria as the CWRF. The grant program provides 80% grant on eligible portions of the project up to a maximum of $7 million dollars.

The proposed alternative would not be eligible for this financing source because the project is not explicitly driven by stringent permit requirements. There is a high potential that the facility will eventually receive nutrient limits, but this will not occur in the current permitting cycle per our correspondence with MPCA.

PSIG funding could potentially be triggered if the City were to voluntarily accept new nutrient limits under a regulatory certainty program. However, this is not recommended due to the uncertainty of potential limits. The proposed alternative provides a phased approach to meeting nutrient limits. Future upgrades to the proposed alternative may also be PSIG eligible once limits are imposed. Therefore, the proposed alternative provides a reactionary approach to nutrient limits while not closing the door on PSIG funding.

E. IMPLEMENTATION SCHEDULE

The proposed implementation schedule for the recommended project is presented in Table 7.3 below.

Table 7.3 – Project Implementation Schedule City of Lanesboro, Minnesota	
Item	**Date**
Review with City / Finalize Report	March 2018
Submit PER to Rural Development	April 1, 2018
Rural Development Approval of PER	June 2018
Design of Improvements	July 2018 – February 2019
Submit Plans and Specifications to RD	February 2019
Plan approval by RD	April 2019
Advertise for Bids	April 2019
Award Contact / Begin Construction	May – June 2019
Complete Construction and Closeout	December 2020

8. CONCLUSIONS & RECOMMENDATIONS

A. GENERAL

Recommended wastewater system improvements for the City of Lanesboro include construction of a new extended aeration activated sludge treatment facility based on the design criteria outlined in Section 3. We also recommend implementing a capital improvements plan to replace the aging sanitary collection system infrastructure, which has significant issues with infiltration and inflow. Details on these proposed improvements are discussed thoroughly in Sections 6 and 7 of this Preliminary Engineering Report.

The proposed improvements will provide a robust and proven treatment technology for meeting current NPDES discharge requirements, while also providing flexibility to upgrade the system in response to future nutrient limits for phosphorus and total nitrogen, if and when imposed by the MPCA. Proposed improvements will provide enhanced operational control and performance over the existing trickling filter process. From a constructability standpoint, the proposed improvements are feasible and can be completed by traditional construction means and methods. The proposed improvements would fit in the adjacent property north of the existing site, which requires procurement of both privately-owned and state-owned land.

After submittal and approval of this Preliminary Engineering Report to the USDA Office of Rural Development, we recommend the City should move forward with the preparation of construction plans and specifications. The City must also evaluate alternative funding options as discussed in Section 7D of this report. Depending on which funding option(s) are selected, Bolton & Menk will work with the City of Lanesboro to secure these funds.